

THE BRITISH
JOURNAL OF SURGERY

THE BRITISH JOURNAL OF SURGERY

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EPONYMS.

BY SIR D'ARCY POWER, K.B.E., LONDON.

XIII. SYME'S AMPUTATION.

THE history of amputations has still to be written. It will not be very long, because until the introduction of anæsthesia the simplest and quickest method was the best both for the patient and the surgeon: for the patient because he underwent the operation with a minimum of pain, and for the surgeon because he could the more easily control the bleeding and there was less tissue to suppurate. Circular amputation, therefore, was the accepted method, though a few brilliant operators used flaps; but even they fashioned them by transfixion and removed the limb at the traditional 'seat of election'. Amputation wounds rarely if ever healed by first intention, so that no stump was weight-bearing, and the majority were tender and irritable for years afterwards. 'The seat of election' was that point in the limb where the end of the stump was most protected and least in the way. The method was wasteful, because it led to unnecessary sacrifice of healthy tissues, and Syme introduced his operation with the statement that "it may be startling, but it is nevertheless true that amputation at the ankle-joint with hardly any exceptions may and ought to supersede amputation below the knee. The idea of amputating at the ankle-joint is not new, the operation having been performed on the Continent by different surgeons before I thought of it; and it would probably ere now have become generally adopted but for the doubt that was entertained as to the ends of the bones being sufficiently covered to afford the patient a useful and comfortable support for the limb. For my own part, when I read of dissecting flaps of skin from the instep or sides of the foot, I felt so much distrust in the protection that could thus be effected against the injurious effects of pressure on a part so exposed to it, that I had no desire to try the experiment. But it occurred to me that by performing the operation in a different way all such objections might be obviated. This was to save a flap from the sole of the foot and thick integuments of the heel, by making a transverse incision and dissecting these parts from the os calcis, so that the dense tissues provided by nature for supporting the weight of the body may be still employed for the same purpose. Two trials of this

operation having proved satisfactory, I communicated them to the profession, and am glad to find that not only my colleagues in the hospital here but also the practitioners in other places have already acted upon this recommendation. The additional experience of my own practice now enables me to suggest some improvements in the mode of procedure—point out an error to be avoided—and verify the expectation formerly expressed as to amputation of the leg being hardly ever required.

“The best instrument for performing the operation is a large bistoury or small amputating knife. There is no occasion for a tourniquet, as the assistant has complete command of the vessels by grasping the ankle. In my first operations the flap was made unnecessarily long; and I feel confident that the following directions may be trusted for exactly determining its proper extent. The incisions across the instep and sole of the foot should be curved with the convexity forwards and exactly opposite each other. A line drawn round the foot midway between the head of the fifth metatarsal bone and the malleolus externus will show their extent anteriorly, and they should meet a little way further back, opposite the malleolar projections of the tibia and fibula. Care should be taken to avoid cutting the posterior tibial artery before it divides into the plantar branches, as in two cases where I did so, there was partial sloughing of the flap. If the ankle-joint is sound, the malleolar processes should be removed by cutting pliers; but if the articulating surfaces of the tibia and fibula be diseased, a thin slice of these bones should be sawn off. The edges of the wound should be stitched together and lightly dressed. When the cure is completed, the stump has the shape here represented (*Fig. 1*), being conical in form and having for its apex, or central

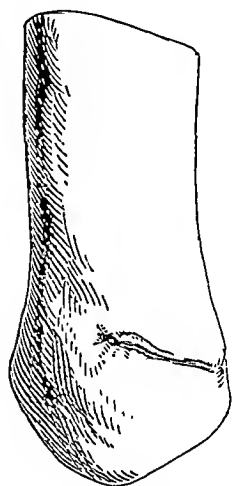


FIG. 1.

point of pressure, the thick integument which covered the heel.

“In proceeding to consider the circumstances in which this operation may be performed, it seems worthy of notice that until a recent period, amputation of the leg was in this country generally resorted to for the removal of diseased bone, when the part affected extended upwards beyond the metatarsus. The operation of Chopart might frequently have accomplished all that was requisite, but unfortunately laboured under a prejudice which opposed its adoption. This was, that the extensors of the heel, being deprived of antagonising action, would point the stump downwards so as to render it useless as a support for the body. In 1829 I ventured upon this partial amputation of the foot, though there was no precedent for it in Edinburgh, in a case where removal of the leg had been proposed, with perfect success and without the slightest inconvenience of the kind anticipated. Encouraged by this result, I resolved to adopt the operation; and before long performed it six times with entire satisfaction. Since that time the operation has been established here and regularly practised in cases admitting of its application.

"Although the introduction of Chopart's operation considerably abridged the field for amputating the leg, there were still two situations in which caries frequently occurs, where it was beyond the reach of any partial removal of the foot. These were the joint between the astragalus and the os calcis and the ankle-joint itself. I was therefore led to think of contriving a method of amputating at the ankle-joint which might afford relief under such circumstances and afford the patient a comfortable stump."

The first patient operated upon was a boy, age 16, who was admitted, probably into Minto House, on Sept. 8, 1842, suffering from disease of the foot, which had suppurated and ulcerated in consequence of a twist which he had given it in walking about twelve months before. The second patient was "Dr. W.", a medical gentleman about 25 years of age; who had been seen in consultation with Mr. Goodsir in the early part of 1843. Both cases did well, and Mr. Syme notes that it was unnecessary to make any counter-opening in the heel flap in the second case, because he had button-holed the heel flap in dissecting it from the bone. "The drain thus afforded has proved so useful by permitting a free escape to the discharge and allowing the edges of the flaps to unite throughout their whole extent, that I think its intentional establishment would always be advantageous." From this time onwards Syme performed the operation so frequently that in August, 1844, he had records of fourteen cases, eight in his own practice and six in that of others, and in no instance had there been a fatal result. Incidentally he mentions the ease with which the operation could be done owing to the recent invention by Robert Liston of the straight cutting pliers for bone, which he hoped would supplant the variously shaped saws previously in use.

It took some years before the new operation assumed its proper position. In 1862 a report was made upon the subject of amputations through the foot and the ankle-joint by a Committee of the Associate Medical Members of the Sanitary Commission of New York. The members of the Commission, which included Stephen Smith, Valentine Mott, A. C. Post, and W. H. van Buren, reported that "the stump after Syme's amputation is much better adapted for an artificial appliance than that resulting from either Chopart's or Pirogoff's operation." In 1873, Mr. Henry Hancock, in his work *On the Operative Surgery of the Foot and Ankle-joint*, after a very careful examination of the recorded cases expresses his most favourable approval of the operation and quotes the just and liberal criticism of Jules Roux, who, after performing the operation for the first time in 1846, said: "It appears to me that by this operation art modifies without changing the language of nature; in fact, the malleoli being removed, the lower extremity of the leg affords a base of support which transversely exceeds that of the os calcis."

The operation continued to excite a considerable amount of attention and some criticism. In 1878 Dr. John A. Wyeth, of the University of Louisville, set himself to work upon the surgical anatomy of the tibio-tarsal region with special regard to amputation at the ankle-joint. He found that in eighty consecutive dissections not a single calcanean branch was given off by the posterior tibial artery before its terminal bifurcation, while in every one of the eighty dissections one or more good-sized calcanean arteries were derived from the external plantar, within one and a quarter inches of its

origin. "In eighty cases," he says, "the number of calcanean branches derived from the external plantar was two hundred and twenty-one, and every one of these was safely inside the line of incision in amputations at the ankle-joint, when that incision is not more than half an inch posterior to the axis of the leg, the foot being at right angles. In all cases articular branches are derived either from the posterior tibial or internal plantar or from both. In some exceptional cases the internal plantar gave off some small branches to the heel. The anterior flap is plentifully supplied by branches from the anterior tibial, especially the malleolar arteries. The anterior and posterior peroneal arteries distribute branches to the outer portion of the calcanean flap, but they are not large enough for the blood supplied by them to maintain the integrity of the calcanean flap, especially when their anastomoses are cut off by division of the posterior tibial or its plantar branches too near their origin."

The illustration is a reproduction of the original drawing which appeared in the *London and Edinburgh Monthly Journal*, 1844, p. 648.

THE RADIOGRAPHIC FEATURES OF URINARY CALCULI IN RELATION TO THEIR CHEMICAL COMPOSITION AND STRUCTURE, WITH SPECIAL REFERENCE TO RENAL CALCULI

By H. P. WINSBURY WHITE, LONDON.

I wish first to acknowledge my indebtedness to Dr. Luey Wills, of the Pathological Department of the Royal Free Hospital, for carrying out the detailed chemical and microscopical examination of the twenty-four renal calculi which are discussed in this paper. I have also to thank Dr. Scott Williamson, Director of Pathological Studies at the London (R. F. H.) School of Medicine for Women, and Mr. Ulysses Williams and his staff at the Radiological Department of the Royal Free Hospital, for their collaboration. My thanks are also due to Miss Sibyl Widdows, Lecturer on Chemistry at the London (R. F. H.) School of Medicine for Women, who analysed several stones for me, and to Sir Arthur Keith, for his kindness in allowing me to borrow for radiographic purposes some of the calculi from the Museum of the Royal College of Surgeons. Finally, I am indebted to the members of the honorary staff of the Royal Free Hospital for permission to publish these notes.

RELATIVE OPACITY OF CALCULI TO RÖNTGEN RAYS.

A true comparison of the density of calculi can only be made by considering shadows of stones which are exposed together on one plate or film. To attempt to compare the relative opacity of objects submitted to the rays at separate times, with differing lengths of exposure, and perhaps with alternative apparatus, can only lead to confusing results. In looking through the literature of this subject, I have come across one instance where sufficient regard had not been shown to these points, with resulting wrong conclusions.

Certain principles have been established by various investigators with regard to the factors which influence the capacity of different bodies to absorb the Röntgen rays. Benoist states a number of laws, as follows :—

The specific opacity of a body for a given quality of X rays and for a standard measured thickness is independent of the physical state of that body. This means that the same transparency of a body will be obtained whether it is in a solid or a liquid state, or in an amorphous or crystalline condition.

The specific opacity of a body is independent of the method of grouping of its atoms or molecules.

The specific opacity is independent of the state of liberty or combination of atoms.

Finally, Arcelin quotes Benoist as saying that the specific opacity of a simple substance depends upon its atomic weight.

As a urinary calculus is generally composed of a variety of constituents, its opacity is therefore equal to the sum of the opacities of those constituents.

The following simple substances may be tabulated in their order of increasing density according to their atomic weights. The numbers represent the atomic weights:—

Hydrogen	1	Sodium	23	Sulphur	32
Carbon	12	Magnesium	24	Potassium	39
Nitrogen	14	Phosphorus	31	Calcium	40
Oxygen	16				

Similarly, combinations of these simple substances can be arranged in their order of opacity according to the sum of the atomic weights of the simple substances.

The reason why the soft parts of the body give so poor a shadow is

because their general density is little different from water, and, above all, because they consist of organic combinations containing almost exclusively hydrogen, carbon, nitrogen, and oxygen, whose atomic weights are low. Arcelin arranged a number of urinary salts in their order of increasing density according to their atomic weights as follows: Ammonium urate; uric acid; sodium urate; magnesium urate; potassium urate; calcium urate; cystine; calcium oxalate; calcium carbonate; calcium phosphate.

The order of the substances in the list is extremely interesting when studied in conjunction with a radiogram of calculi of known chemical composition. It must be borne in mind, however, that most urinary calculi are very composite structures with regard to the variety of their urinary salts. Nevertheless, it frequently happens that a stone consists sufficiently largely of one particular constituent to give some indication of the composition by radiogram. Again, the actual thickness of a stone will cause the opacity to vary. But, as Bécélère points out, if two calculi are of different thickness, it is not necessarily that of greater depth which gives the denser shadow. The density

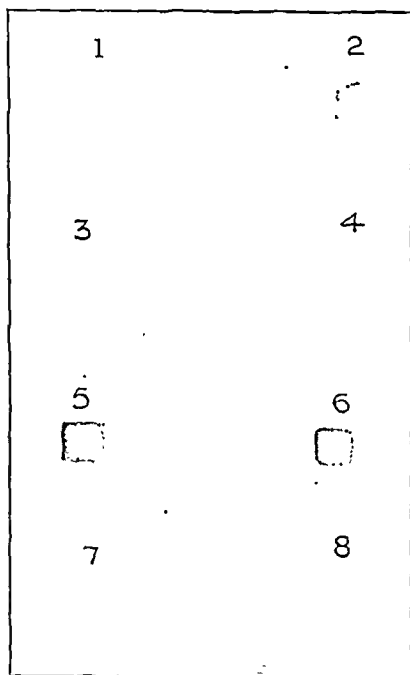


FIG. 2.—Portions of urinary calculi of equal depth, to indicate variations in opacity. 1, Uric acid; 2, Mixed urates; 3 and 4, Triple phosphate with trace of calcium; 5, Earthy phosphate; 6, Calcium oxalate; 7, Cystine with a trace of calcium; 8, Xanthine with a trace of calcium.

will be in proportion to the sum of atomic weights of the different elements through which the rays pass. Further, Arcelin indicates that the actual structure of the stone has to be considered. Thus, a porous structure will cause a less dense shadow than a more compact one. He therefore lays

down that the opacity of a calculus is determined by: (1) The nature of its constituents; (2) Its structure; (3) Its thickness.

He took a number of calculi, reduced them all to a depth of 4 mm., and submitted them together to the same exposure of Röntgen rays. The stones were then examined chemically. As a result of his investigation he was able to arrange the following substances in the order given, which represents their relative opacity to one another, the first substance being the least dense: Uric acid; urate of calcium and of magnesium; ammonio-magnesium phosphate; phosphate of calcium and of magnesium; oxalate of calcium; phosphate of calcium. This order satisfies the laws of Benoist.

I have carried out similar experiments by cutting eight cuboidal pieces of stone, each 5 mm. in height, from stones previously chemically examined, in an endeavour to demonstrate the relative opacity of some of the constituents, most of which are common and a few rare. *Fig. 2* represents a radiogram of these. The cubes have been cut small, as in this way there was more likelihood that they would have the same composition throughout.

It will be seen that uric acid gives the poorest shadow. It can barely be distinguished on the print. Calcium, so commonly present in urate stones as calcium urate, causes a greater density in No. 2 than is to be seen in No. 1. No. 2 has a fine line of calcium oxalate along its upper edge; but the rest of the cube may be taken as a mixture of uric acid and urates. Nos. 3 and 4, representing chiefly triple phosphate, owe their density for the most part to the presence of a small amount of calcium; when one considers the formula of triple phosphate, with its abundance of ammonium, a shadow of great density is not anticipated. Nos. 5 and 6, calcium phosphate and calcium oxalate respectively, give good shadows of almost equal density, that of the former being slightly more opaque than the latter. This is in conformity with the relative molecular weights. Cystine and xanthine, Nos. 7 and 8, give poor shadows compared with the two foregoing, but they also each contain a small amount of calcium.

OUTSTANDING PHYSICAL CHARACTERISTICS OF THE RENAL CALCULI UNDER INVESTIGATION.

Two separate groups of stones will now be considered. Each group comprises three photographs, as follows: (a) Stones before section; (b) Stones after section; (c) Radiogram of stones before section. *Group I* is shown in *Figs. 4, 5, and 6*; *Group II* in *Figs. 12, 13, and 14*.

It is not intended to go into a detailed description of all the physical characters of the stones. These features do not appear to be relevant to the purpose of this paper, and are difficult to appreciate from the photographs. The chief feature common to all the stones is that each occupied and developed in the pelvis of a kidney, and as in each case the pelvis was occupied by a single stone, we are dealing in no instance with two stones from the one kidney.

The actual size which any such calculus attains depends upon whether the excreting capacity of the kidney is destroyed at an early or at a late stage in the disease. For example, stone No. 7 of *Group I*, one of the smallest stones in the series, measuring one inch in its longest diameter, by giving rise

to back pressure and infection had caused every particle of excreting renal tissue to disappear, leaving only a fibrous shell. *Fig. 3* shows the stone in the actual kidney. Stone No. 6 of *Group I* was removed from a kidney which was found to have a good deal of functioning tissue; the renal organ was therefore not removed, and has been carrying on its work fairly well for the past eighteen months without any recurrence of stone. Such examples as these should be a reminder of the difficulty in trying to assess the value of a kidney from the X-ray appearances of a stone which it contains.



FIG. 3.—Shows a small calculus in the pelvis of a kidney which has had all of its excreting tissue completely destroyed as a result of back pressure and infection.

The tendency is for the stone to form a cast of the larger channels forming the drainage system of the kidney, the building-up process being most active where the urine from the primary calices first comes in contact with the stone. Thus, commencing from a stone in the pelvis, a cast of this will first be formed, from which stems will project towards the main calices. How far the process will go will depend upon what stage is reached when the kidney ceases to function as an excreting organ, for at this point the stone will cease to grow. With one or two exceptions it will be seen that there is in each case a tendency for the formation of a central triangular-shaped portion. This occupied the kidney pelvis. The stones have been arranged so that the portion which projected into the ureter is directed downwards. There is one exception to this: in *Group I*, No. 10 is upside down in *Figs. 4 and 5*. In *Group I*, all of the stones except

the rounded one show the calical process in some degree of formation—in some more than others.

Nos. 2, 6, and 12 of *Group I* show, in addition, casts of the secondary calices. No. 1 is a very unusual shape for a kidney stone, resembling more a vesical calculus. It developed in the already distended pelvis of a hydro-nephrosis; hence its rounded appearance. No. 6 of *Group II* has barely commenced to assume its triangular shape. No. 5 of *Group I* and No. 11 of *Group II* have a common characteristic in that the stem of each corresponding to the primary lower calix is well developed, and that the one corresponding to the upper has developed but slightly. There are two possibilities in explanation of these appearances. Either the stone was built upon the nucleus as it lay in the lower calix and eventually extended into the pelvis, or else the back pressure caused by the original stone in the pelvis destroyed the excreting tissue drained by the upper calix before that which drained into the lower, so that the building process could proceed in the lower calix long after it had ceased in the upper. The latter is the more acceptable explanation, because distention is always greater in the superior than in the inferior calix. This

point is also illustrated to a slight extent in Nos. 6 and 12 of *Group I*, where it will be seen that the casts of the secondary calices are more advanced on the lower stem than on the upper.

The colours of the stones are not to be appreciated in detail from the photographs, but a few points can be made out. The white or grey coat seen on some is all phosphatic. Stone No. 3 of *Group I* has a black coat consisting of laminated partly-organized blood-clot, which could be peeled off readily. No. 12, *Group II*, has also a black coat due to blood pigment. It is impossible to appreciate the true variations in shade of the other stones, which showed mostly different degrees of brown. The outer aspect of the cystine stone (No. 3, *Group II*) was light brown. The oxalate stones varied from dark straw colour to very dark brown or maroon, according to the amount of blood pigment incorporated. Most calculi have several kinds of salts in their composition, and it is only when certain salts predominate largely that the colour gives an indication of the chemical composition. Therefore the question of colour is not always of importance in indicating the nature of a stone, especially as a cross-section may reveal quite a different appearance beneath the surface.

In association with many of these stones were smaller ones lying in the dilated calices, and on handling some of the main calculi an indication of their existence is manifested by the presence of facets or small roughened areas from which portions of stone have been broken. These smaller stones may be few or many, and generally have the same chemical composition as the large stone in the pelvis. (*See Figs. 7-11.*)

These points can hardly be appreciated from the photographs, but are quite obvious on handling the specimens. In *Fig. 5*, Nos. 1, 2, 9, and 10, and in *Fig. 13*, Nos. 4, 6, 8, 11, and 12, each show a central portion different in colour from the main mass of the calculus built round it. This is the nucleus or first portion of the stone to be formed. In the remaining stones the nucleus is not clearly defined, because the urinary salts forming the original deposit have continued to form a considerable bulk of the stone.

THE CHEMICAL COMPOSITION OF INDIVIDUAL CALCULI IN RELATION TO RADIOGRAPHIC APPEARANCES.

The radiograms of the stones of *Groups I* and *II* (*Figs. 6, 14*) were taken before section of the stones, with the exception of No. 11 of *Group I* and No. 5 of *Group II*. The antero-posterior diameters refer to measurements of the central portions taken before division. No. 11 in *Group I* again being an exception.

GROUP I (*Figs. 4-6*).

No. 1.—Concentric lamination can be seen. In spite of the variations in colour, each stratum is principally composed of oxalate of lime, the variations in shade being accounted for by differing proportions of organic matter present. The diameters of this stone were 4 cm. transverse and 3.1 cm. antero-posterior.

The radiogram shows a shadow of considerable density, as would be expected after considering the foregoing remarks about this salt.

GROUP I.



FIG. 4.—Twelve stones, each removed from the pelvis of a kidney. All except No. 1 show evidence of the ureteric process and the two caliceal stems.

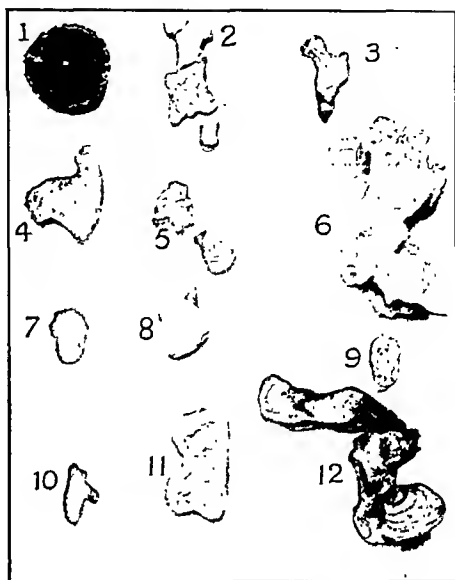


FIG. 5.—The stones of *Fig. 4* cut to show their internal structure.

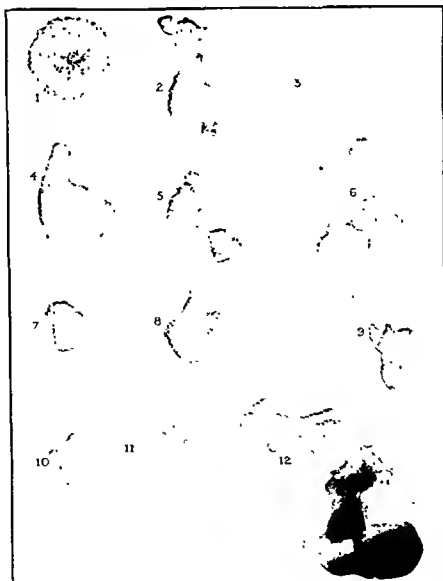


FIG. 6.—Radiogram of the stones of *Fig. 4* to show the variations in opacity.

No. 2.—The small light oval area in the middle of the stone is the nucleus, and is composed mostly of uric acid with a little oxalate. In the surrounding darker area the salts are the same, but the proportions are reversed. The bulk is oxalate, uric acid being present only as a trace. The whitish portions forming the two stems consist of a mixture of calcium magnesium and triple phosphates. The latter salts indicate that ammoniacal decomposition of the urine eventually resulted. Antero-posterior diameter, 1.6 cm.

In the radiogram the nucleus can barely be distinguished as a small area faintly paler than the surrounding darker zone. This is, as one would expect, from the large proportion of uric acid present. The dark zone around this nucleus is clearly defined from the lighter shadows of the stems, the poor opacity of which is due to the large proportion of triple phosphate present. The darker areas at the extremities are due to the calcium present in the earthy phosphate in these situations. These features can be seen also in the clinical radiogram (Fig. 7).

No. 3.—The cut surface shows as a fairly uniform dark colour. The lower end has been broken in cutting, and the laminated blood-clot seen on the outer surface dislodged. The nucleus is only faintly discernible on the right-hand margin just above the broken portion at the lower extremity. Antero-posterior diameter, 1.6 cm.

The radiogram is interesting. The bulk of the stone is barely visible, whereas the nucleus is more plainly seen as a small darker area towards the lower end, on the right-hand margin. The explanation of the difference in opacity is that the nucleus consists of uric acid and urates, with the latter in preponderance. In the rest of the stone the proportions are reversed.

The opacities of Nos. 3 and 2 should be contrasted, as they have the same antero-posterior diameters.

No. 4.—The cut surface shows the structure of the central portion to be maintained throughout a considerable bulk of the stone. There is no visible circumscribed small nucleus. It is a good example of a stone consisting of many constituents. It contains largely oxalate, a little calcium magnesium (earthy) phosphate, and a trace of uric acid. The upward projecting stem is of earthy phosphate. Antero-posterior diameter, 2.3 cm.

In the radiogram the main mass gives a considerable opacity, from the



FIG. 7.—Radiogram of large branched calculus in kidney. Differences in opacity of different parts of the calculus can be clearly made out. Two small calculi can be seen in the region of the middle calices. (See calculus No. 2, Group I.)

large amount of calcium oxalate with the addition of earthy phosphate. The superior stem, of much smaller antero-posterior diameter than the main mass, consists of calcium magnesium (earthy) phosphate only. *Fig. 8* shows the dense shadow of the clinical radiogram resulting from a stone of this size and consisting largely of the more opaque constituents.

No. 5.—The cut surface shows the pelvic portion to have the same appearance throughout. Chemically it was found to be a mixture of calcium magnesium phosphate and calcium oxalate. The downward projecting calical part has a dark and a light area in which two fine laminæ can be seen. The whole of this portion is a mixture of calcium oxalate and earthy phosphate. The dark area and the fine dark laminæ owe their colour to the presence of

fibrin. Thus throughout the stone the same salts are found, but undoubtedly in varying proportions as shown by differing radiographic densities. Antero-posterior diameter, 1.6 cm.

The radiogram clearly illustrates that contrast in colour does not necessarily represent contrast in inorganic constituents. In the clinical radiogram, *Fig. 9*, the variations in opacity can also be made out.

No. 6.—The cut section in the photograph shows a whitish surface more or less uniform throughout, as was also noted on the outer aspect. On inspecting the actual specimen, however, a large central mass in the pelvic portion is seen to be



FIG. 8.—Radiogram of large branched calculus *in situ*. Note the good density of the shadow, due to the presence of a large amount of calcium; also note the small calculus in the lower calix. (See calculus No. 4, Group I.)

in contrast with the remainder. Chemically, the stone is unusual, the central portion being composed of cystine and xanthine. The rest is made up of triple phosphate with a small area of earthy phosphate. There is a trace of calcium throughout. Antero-posterior diameter, 2.1 cm.

The radiogram shows a poor opacity. This is to be expected in a stone of this composition. A narrow dark band about the middle indicates some calcium magnesium phosphate. The increased density of the stem projecting to one side at the lower part of the stone is due to the extra depth of the calculus here. There is no striking difference between the density of the central portion consisting of cystin and xanthine, and the rest made up of triple phosphate. *Fig. 10*, a radiogram showing the stone before removal from the patient, illustrates the poor shadow given by this large calculus.

FIG. 9. — Radiogram of large calculus in kidney. It occupies the lower primary calix and the pelvis of the kidney. Small calculi are seen in the lower calices and the upper middle calix. Note the variations in opacity of the main stone. (See calculus No. 5, Group I.)

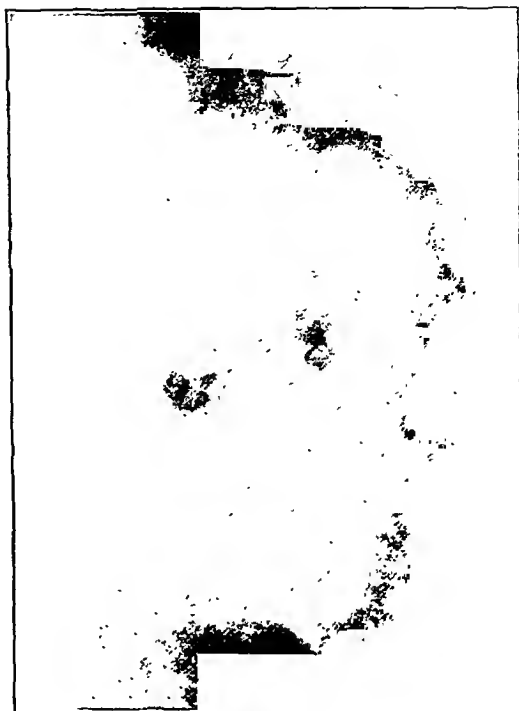


FIG. 10.—Radiogram of a large stone consisting of cystine, xanthine, triple phosphate, and a small amount of calcium. Note the poor shadow for so large a stone. (See calculus No. 6, Group I.)

No. 7.—The cut section shows a uniformly brownish colour throughout. Chemically, the stone consists of calcium magnesium phosphate and calcium oxalate with a trace of uric acid. Antero-posterior diameter, 2.1 cm.

The radiogram gives a shadow of good density, as would be expected.

No. 8.—The cut surface is shown as a uniformly white mass throughout. Chemical examination shows a composition largely of triple phosphate, with earthy phosphate in smaller proportion, but sufficient to give a good opacity in the radiogram. Antero-posterior diameter, 1.8 cm.



FIG. 11.—Radiogram of large renal stone, with many smaller stones. Good density on account of much calcium present as oxalate and phosphate. (See calculus No. 11, Group I.)

No. 9.—The cut surface shows a definite rounded central area occupying about one-third of the stone. The radiogram shows a nucleus as a light area surrounded by an irregular dark zone. Beyond this is the cortex forming an area intermediate in density. Chemically, the nucleus is uric acid and urates. The irregular dark zone is calcium oxalate, earthy phosphate, and uric acid. Obviously uric acid dominates in the nucleus, and calcium oxalate and earthy phosphates in the irregular dark zone. The cortex is earthy phosphate. Antero-posterior diameter, 1.4 c.m.

No. 10.—The cut section shows a sharp contrast between the oval light-coloured nucleus, and the dark surrounding cortex. Chemical examination of the nucleus gave uric acid and urates. The cortex consists largely of oxalate, with traces only of uric acid. Antero-posterior diameter, 1.3 cm.

The radiogram bears out the chemical findings, as the nucleus is seen as a central light area.

No. 11.—The cut surface shows the bulk of the calculus to consist of a large central whitish zone. The small irregular dark areas appearing in this zone are simply excavations due to

portions broken away during the cutting. Surrounding this area is a dark lamina, and at the top of the stone there is a whitish mass superimposed. Chemically, the composition shows itself as a mixture of calcium magnesium phosphate and calcium oxalate. The thick dark band round the edge consists entirely of calcium oxalate.

The small antero-posterior diameter, 1.2 cm., explains why the shadow is so lacking in density. The stone had been divided before the radiogram was taken. The areas where portions have fallen away during the cutting

are seen as lighter zones. The clinical radiogram (*Fig. 11*) shows the dense shadow given by the greater depth of calcium oxalate present in the unsectioned stone.

No. 12.—The cut surface does not show clearly the variations in colour which are apparent on viewing the actual specimen, in which is seen a definite nucleus about half an inch in diameter and dark brown in colour. Throughout the remainder of the stone, definite laminae of alternating light and dark bands are apparent. These are clearly seen in the photograph in the anterior of the two lower calical branches. Antero-posterior diameter, 2.2 cm. Chemically, the nucleus consists of a mixture of blood-clot, oxalate, and earthy phosphate. These constituents are contained throughout the stone, the dark laminae owing their colour to the presence of fibrin.

In the radiogram the general density of the shadow is good. This would be expected from a mixture of oxalate and earthy phosphate. The laminations are also to be seen.

GROUP II (*Figs. 12-14.*)

No. 1.—The internal structure does not show any definite nucleus. Several small dark areas are due to pitting, indicating a somewhat porous structure. Chemically, the stone consists of calcium oxalate throughout, with some organic matter in the centre. Antero-posterior diameter, 1.9 cm.

The radiogram shows a good density.

No. 2.—The internal structure is uniformly grey. Chemically, uric acid forms the bulk, with a trace of urate and calcium oxalate, of which there is a thin coat round the edge. Antero-posterior diameter, 1.4 cm.

The radiogram indicates by the poor shadow the large proportion of uric acid. The oxalate on the edges is seen as a slightly darker band.

No. 3.—The cut surface, of a grey colour, has a somewhat porous appearance. There is no definite nucleus visible. Both microscopically and chemically, cystine was the chief constituent detected. There was a small amount of calcium throughout. The outer surface of the stone was light brown, and uniformly covered with a fine crystalline deposit of cystine. There were several large facets present, where articulation had occurred with smaller calculi. There were seventeen other cystine calculi present in the calices, ranging from 1 to 2 cm. in diameter. All were removed by nephrolithotomy from the left kidney of a female, age 32. Calculus No. 6 in *Group I*, consisting of cystine, xanthine, and triple phosphate, was removed from the right kidney of the same case a few months before. Antero-posterior diameter, 3 cm., one of the deepest stones in the collection. Length of stone, 6 cm.

The radiogram shows a fairly good central opacity on account of the depth and the presence of a certain amount of calcium, but towards each extremity, where the depth is less, the opacity is poor. The radiogram of the patient showing stones before removal from the kidney (*Fig. 15*) is interesting, as only a few of the smaller calculi can be seen, in addition to the main stone, which does not give a very good shadow. The radiograms illustrating the right and left calculi *in situ* do not necessarily indicate the true relative opacity of each calculus, as the length of exposure was probably different.

GROUP II.

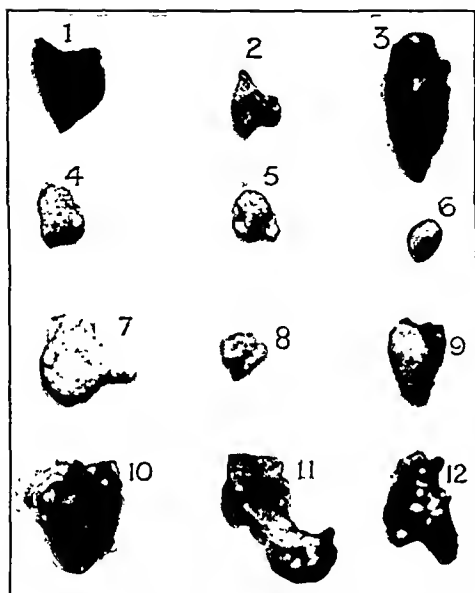


FIG. 12.—A second group of twelve stones each removed from the pelvis of a kidney. The characteristics of shape of such stones are to be noted in all except No. 6.

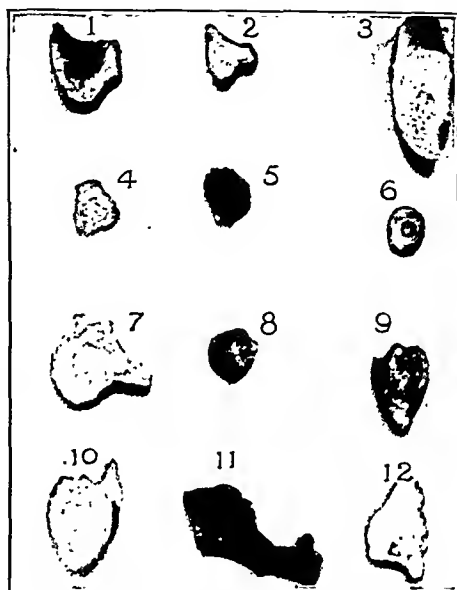


FIG. 13.—The stones of Fig. 12 cut to show their internal structure.

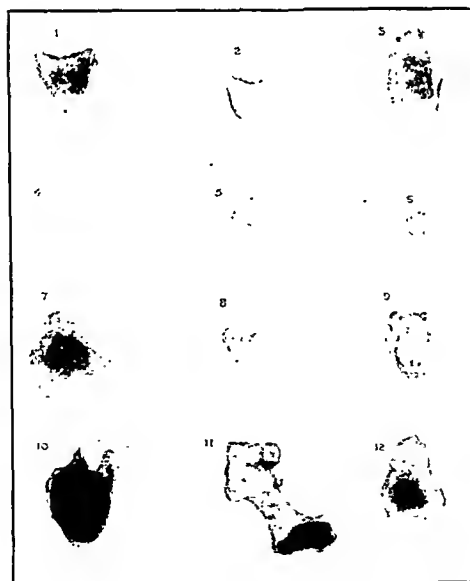


FIG. 14.—Radiogram of the stones of Fig. 12 to show the variations in opacity.

For the same reason the shadows in *Group I* cannot be compared with those of *Group II*.

No. 4.—Cross-section shows a large pale central area surrounded by a slightly darker zone. Chemical examination proves the nucleus to be a mixture of uric acid and earthy and triple phosphate. The outer zone is pure triple phosphate with organic matter. Antero-posterior diameter, 1.8 cm.

In the radiogram the nucleus shows clearly on account of the earthy phosphate present, whereas the outer zone can barely be distinguished, so poor a shadow does the triple phosphate give.

No. 5.—On section this is uniformly dark brown, with a fissure running from the lower border towards the centre, and several pits. A thin outer coat of grey is visible above and below. Chemical examination shows a mixture of earthy phosphate, calcium oxalate, and fibrin. In the main mass, the outer coat is mostly earthy phosphate with a little fibrin. Antero-posterior diameter, 1 cm.

The radiogram, representing one-half of the stone only, shows irregular variations in opacity, due to deficiencies and irregular distribution of the salts.

No. 6.—Cross-section shows definite pin-head nucleus, surrounded by two clearly defined circumscribed broad laminae. Chemical examination shows that the nucleus and inner circumscribed area consist of uric acid and urates, the outer zone of calcium oxalate. Antero-posterior diameter, 1 cm.

The radiogram shows absence of opacity in the central area corresponding to the distribution of the uric acid and urates. There is not enough of the latter present to throw a shadow. The oxalate zone is well seen.

No. 7.—The outer surface is covered with a grey deposit. Cross-section shows a large central nucleus surrounded by a paler area and, finally, by the grey coating seen on the outer surface. On chemical examination, the nucleus was found to be largely calcium oxalate, with traces of urate and uric acid. Adjacent to the nucleus is a broad area consisting of a mixture of oxalate, and calcium magnesium and triple phosphates. The outermost zone consists of a mixture of earthy and triple phosphate and a little carbonate. Thus the stone contains all the common salts found in urinary calculi, and, by considering the composition of the three zones, it can be seen how the infective changes in the urine became more marked as time progressed. Thus, the nucleus

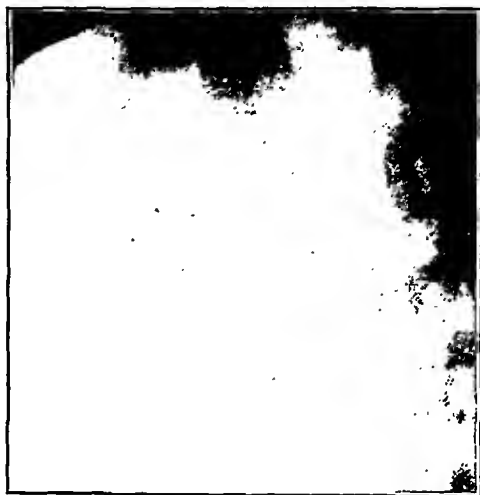


FIG. 15.—Radiogram of a large stone in pelvis of left kidney, with smaller stones in calices; eighteen stones in all were removed from the kidney. The smaller stones do not show in the radiogram. The stones consisted of almost pure cystine, with a little calcium. Figs. 16 and 15 are from a case of bilateral cystine stone in a woman, age 32. (See calculus No. 3, *Group II*.)

manifests no sign of gross infection; the adjacent zone, however, demonstrates that infection had supervened, as here the constituent (calcium oxalate) forming the bulk of the nucleus is found mixed with triple phosphate; while in the outermost zone there is no oxalate at all, but triple phosphate is found in abundance, with a little calcium carbonate. Large masses of phosphate may form very quickly in the presence of severe and persistent infection of the urine, whereas oxalate formation is very slow. Antero-posterior diameter, 2 cm.

The radiogram shows a considerable area of good density centrally, due to the larger amount of oxalate and earthy phosphate here. The outermost zone, most marked in the lower part, gives the poor opacity characteristic of triple phosphate.

No. 8.—The cut surface shows a uniform dark colour, as seen on the outer aspect. Chemical composition, calcium oxalate and a little blood pigment. Antero-posterior diameter, 1 cm.

The radiogram shows a fair amount of opacity, considering that the depth of the calculus was only 1 cm. Several linear light areas are to be made out; these are due to fissures in the stone.

No. 9.—The cut section shows a uniform dark surface without any evidence of a nucleus. There are several excavations. As regards its chemical composition, the bulk of the stone is mainly calcium oxalate, with a little earthy phosphate; there is an outer coat of earthy phosphate. Antero-posterior diameter, 1.8 cm.

In the radiogram, the irregular areas of poor density correspond with the excavations seen in the cross-section. The outer coating of earthy phosphate is only faintly seen, as it is very thin.

No. 10.—Cross-section shows a greyish surface, more or less uniform in appearance. Chemical examination shows that the stone consists almost entirely of calcium oxalate, except for some fibrin about the middle. Antero-posterior diameter, 3 cm.

The radiogram shows a very dense shadow, as would be expected from an oxalate stone of this depth. This shadow may with advantage be compared with No. 3 of this group, the cystine stone, as both have the same antero-posterior diameter. There is a striking difference in density.

No. 11.—The broadest portion of this elongated stone is the part which occupied the pelvis. The cross-section shows an elongated nucleus, surrounded by a rounded light area. The rest of the stone is uniformly dark brown. Antero-posterior diameter, 2 cm. As regards the chemical composition, the nucleus consists of urates, surrounded by blood-clot. The pale, somewhat rounded area encircling the nucleus is earthy phosphate. The dense area in the lower extremity is calcium magnesium phosphate and oxalate. The pale parts consist largely of triple phosphate.

The radiogram shows considerable contrast between the upper three-quarters of the stone and the lower quarter, which has a greater density.

No. 12.—Cross-section shows a clearly-defined small irregular dark nucleus, situated in a white zone, which is separated from the main mass of the stone by a thin dark lamina, outside which the white again prevails, being edged by a thin dark border. The chemical composition of the nucleus shows calcium

oxalate only. The surrounding zone within the darker lamina consists of a mixture of oxalate, and earthy and triple phosphate; beyond this, triple and earthy phosphate and calcium carbonate. Here, as in No. 7, there is evidence of progressing sepsis as the stone increases in size. Antero-posterior diameter, 2·2 cm.

In the radiogram, the more marked density of the central portion, due to calcium oxalate, disappears towards the periphery, as the oxalate and earthy phosphate are replaced by triple phosphate.

PREVIOUS INVESTIGATIONS OF THE CHEMICAL COMPOSITION OF URINARY CALCULI.

Much work in the past has been done on this subject. Most of the earlier observers considered uric acid and urates the most important constituent of urinary stones. But considerable differences in percentages have been recorded. To take a few instances: Thomson-Walker notes that out of 649 urinary calculi in the Hunterian Museum examined by Beneki, 74 per cent contained uric acid or urates. An inspection of the Hunterian collection of calculi in the College of Surgeons shows that the large majority are vesical stones. Dickenson examined 91 renal stones, and found uric acid or urates in 70 per cent. He also found oxalate of lime in 63 per cent. He quotes the findings of two other observers—Benec-Jones, who says that 75 per cent of all renal calculi are uric acid, and Roberts, who states that five-sixths are thus composed. Küster examined 511 renal stones; among the numerous constituents that he identified, he found uric acid or urate in only 3 per cent, oxalate in 22 per cent, and phosphate in 31 per cent; he found xanthine in 3 per cent; he was also able to identify iron and cholesterol in separate single stones, and indigo in 2. Ultzman, in 545 stones, found uric acid in 81 per cent, oxalate of lime in 5·6 per cent, and phosphate in 1·4 per cent. Morris, for 77 calculi, gives the following figures: oxalate of lime 44·15 per cent, uric acid 22·07 per cent, phosphate 16 per cent. Rosenbloom and Kahn, in a second series of 26 renal calculi examined chemically, found more than 60 per cent of oxalate in 66 per cent of the total, and smaller percentages in all of the remaining stones; even in two stones each having more than 90 per cent of uric acid, small amounts of oxalate were detected. The same two observers, in a previous report on 26 urinary stones, stated that the majority of these were composed of calcium oxalate. In this report there is no discrimination between kidney and bladder stones. Moore has examined 21 calculi from kidney or ureter, and found oxalate in over 70 per cent. Thus the conflict of figures goes on according to the numbers of observers we quote, but the later investigators have tended to find more oxalates than the older ones.

There are several possible explanations of the diversity of opinion: (1) The failure in some cases to quote separately the findings of bladder and kidney stones. Vesical calculi have greater proportions of uric acid and urate in their composition than have renal calculi. (2) In some instances one or more constituents have been sought without reference to others. (3) The inclusion of multiple stones from the same bladder or kidney in a series

submitted to examination would lead to a wrong conception of the relative incidence of the different salts in urinary stone, as multiple stones from the one source tend to have the same composition. They are relatively frequent.

SUMMARY OF CHEMICAL ANALYSIS OF STONES UNDER INVESTIGATION, AND CLINICAL SIGNIFICANCE OF CHEMICAL COMPOSITION.

These researches have added yet another series of figures to the literature of the subject, but agree with the results of the majority of modern observers in demonstrating the presence of a high percentage of calcium oxalate. Of the 24 renal stones investigated, it was found that 75 per cent contained calcium oxalate and 58 per cent calcium phosphate in considerable amounts, and for diagnostic purposes it is worthy of note that one or other of these salts of

such good opacity to X rays was present in 91 per cent. In 66 per cent one or other of these salts was found in the central portion of the stone. This is of some importance when it is recalled that many stones give rise to the most severe colic when they are relatively in the nucleus stage, and detection by radiogram while so small will depend to a great extent on their chemical composition. In 11 stones (45 per cent) some proportion of uric acid was detected, and in all of these calcium oxalate or calcium phosphate was noted as well, so that with none of these stones did the presence of uric acid cause a serious danger that the stone would be overlooked in a radiogram.

There were four calculi (16 per cent) with a small nucleus consisting principally of uric acid, well defined as a clear central area in the radio-

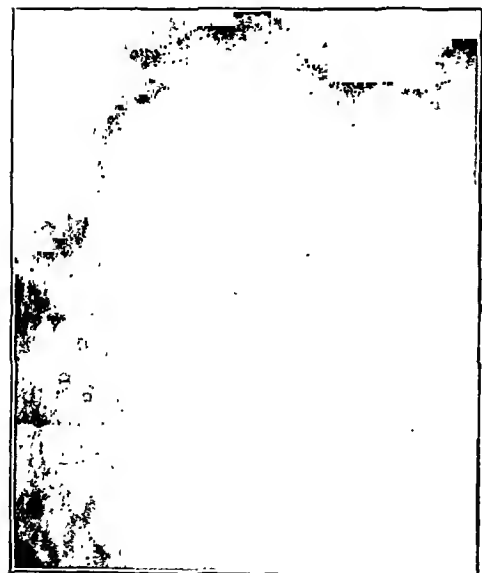


FIG. 16.—Radiogram of calculus in pelvis of kidney. The uric acid centre can be made out from the poor opacity.

grams, Nos. 9 and 10, *Group I* (Fig. 6), and Nos. 2 and 6, *Group II* (Fig. 14). These small masses could give rise to severe symptoms while still in the nuclear stage, and would be very difficult to identify by radiogram.

Six stones (25 per cent) contained urates in addition to uric acid. These salts also help in a slight degree to increase the density of the latter substance, owing to the frequent incidence of calcium urate, which gives a more dense shadow than the other urates. Fig. 16 shows a radiogram of a uric acid stone in the kidney pelvis coated with more opaque salts which enable it to be

identified. Of ammonium urate, which is less dense than uric acid, and the least dense of all the urates to X rays, Leguen says, "Usually the ammonium urate is mixed with urates of sodium, potassium, and calcium". *Fig. 17* shows an ammonium urate stone in the kidney of a child, made evident in the radiogram by the presence of other salts.

Six stones, 25 per cent of the series, contained triple phosphate, in two cases with carbonate in addition. Thus in all there is evidence that gross infective changes had occurred in the urine. One would not have been surprised to find these salts mostly in the composition of the largest stones, but such a finding was not without exception. The largest stone (No. 12 in *Group I*) had none, and one of the smaller ones (No. 4 in *Group II*) had these salts actually in the nucleus, indicating severe infective urinary changes in the early stage of the calculus formation. In searching for information as to the opacity of triple phosphate, in one instance only could a reference be found stating that triple phosphate gave a poor shadow by radiogram. The majority of writers merely indicated that phosphate gave a good shadow. From a comparison, however, of their molecular weights, the relative difference in density is obvious.

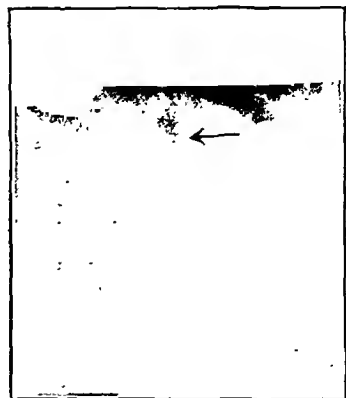


FIG. 17.—Radiogram showing ammonium urate stone in kidney of child. The opacity, which is poor, is due to the presence of a small amount of calcium.

With regard to the stones containing cystine and xanthine, they were both removed from the same patient. From the left kidney there were also taken a number of small cystine stones, and from the right a large branched stone consisting of cystine, xanthine, triple phosphate, and calcium carbonate.

CLINICAL ASPECT OF URIC ACID STONE IN KIDNEY, AND OF URETERIC CALCULUS.

For practical purposes it may be said that any large kidney stone will show on a good radiogram. But it must be borne in mind that though a pure uric acid kidney stone may be large, it will require skill and a good apparatus to demonstrate its presence, especially in a stout patient. Arcelin records with justifiable pride a personal triumph in identifying a pure uric acid stone, weighing 33 gm., forming a perfect cast of the pelvis and calices of the kidney, in a patient 25 cm. in depth. The shadow of the stone was of the same density as that of the kidney in which it lay.

The necessity for good radiography is, of course, more obvious in considering the presence of small stones. Leguen states that a calculus smaller than a pea cannot be expected to give a shadow. I have before me at the moment an oxalate stone 4 mm. \times 3 mm., passed per urethram. This stone had previously been clearly identified in a radiogram in the pelvic portion of

the ureter. Arcelin is more correct when he says that pin-head calculi of any composition cannot be identified.

The smaller stones often pass quite silently. Small rough stones, by causing congestion of and injury to the mucous lining of the ureter, are more liable to give rise to symptoms than smooth stones of the same size. Many oxalate stones are perfectly smooth, and may pass as quietly as those of uric acid of a similar size. The majority of oxalate stones, however, have a rough exterior, and even very small ones are apt to give rise to hæmaturia, if not to colic, while passing down the ureter.

It is doubtful if an oxalate stone large enough to set up colic could not be identified by radiogram; but there are numerous examples of colic due to a ureteric calculus not to be detected in this way. Graves published an instructive case in which an ordinary radiogram had been negative, but a ureterogram demonstrated a clear area in the lower end of the ureter about the breadth of, but a little shorter than, a date-stone. The stone was passed per urethram a few days after the examination. It must not be forgotten, however, that the symptoms often considered typical of stone can be exactly simulated by other diseased conditions of the kidney or ureter.

Chemical examination of ureteric stones reveals oxalates as the commonest variety. By ureteric stones is meant those which become impacted in the ureter. Marion has the following note: "The most frequent are oxalates, then carbonates and phosphates, then uric acid or urates, pure or associated with phosphates or oxalates".

From a comparison of bladder and renal stones, it would appear that more of the uric acid variety reach the bladder than do those of oxalate, and in many cases without an antecedent history of colic, and therefore often do not call for radiographic investigation. When, however, symptoms are present, with a negative radiogram, a criticism by Arcelin should be most helpful in deciding the question of surgical interference. He says

that during a period of seven years, up to the time of writing, he had not known a surgeon explore for a uric acid calculus that had not been identified by X rays. It certainly has long been the custom for urinary surgeons to hesitate to perform exploratory operation upon a kidney or ureter for stone in the presence of a negative radiogram.

Fig. 18 is a radiogram of a number of calculi showing considerable differences in opacity. The majority are stones which formed in the ureter, as is indicated by the prevailing elongated shape. The uric acid stones are easily

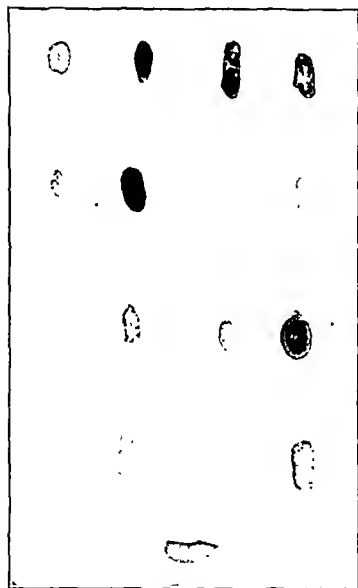


FIG. 18.—Radiogram showing contrast in shadows of stones containing good proportions of calcium, with uric acid stones. The majority are ureteric stones, and the less dense ones would be difficult to identify in the ureter by radiogram. (From the Royal College of Surgeons' Museum.)

picked out by their poor density, and it must be obvious that these would be extremely difficult to detect in a radiogram. It may be added, however, that none of these uric stones became impacted in the ureter; all eventually passed into the bladder.

VESICAL CALCULI.

GROUP III (*Figs. 19-21*).

Fig. 19 shows a collection of vesical calculi. Stones which lie free in the bladder maintain their characteristics of shape, as do renal and ureteric calculi. They are spheroidal, ovoid, or discoid.

A study of the large collection of vesical calculi in the Museum of the Royal College of Surgeons of England shows that in the majority uric acid and urate form a much larger bulk of the individual stones than they do of renal stones. It is not an uncommon experience to find in the bladder on cystostomy a stone of moderate size which was not revealed by radiogram. The identification by radiogram of many bladder stones, whose composition is largely uric acid or urate, is often due to the presence also of calcium in the form of earthy phosphate or oxalate.

Fig. 19 shows the large amount of phosphate present on the outer surfaces of many of the stones, all of which are from the bladder. The phosphatic deposit shows as a grey or whitish coat.

Edward Keyes, of New York, gives a table illustrating the results of radiography in a consecutive series of cases in which stone was present. The relatively large number of bladder stones not identified by radiogram indicates the greater proportion of uric acid in these: In stones in the renal pelvis there were 32 positive results, and 6 erroneously negative; in vesical stones 16 were positive, and 12 erroneously negative.

Group III shows three different photographs of a group of 28 or more vesical calculi, removed in a series of operations by various surgeons at the Royal Free Hospital. They are numbered from 1 to 28.

Fig. 20 is a radiogram of the stones shown in *Fig. 19*. Stones numbered 1, 2, 3, 4, and 7 give scarcely any shadows at all, and Nos. 6, 8-12, 17, 18 and 22 all give poor shadows, while Nos. 5, 13, and 24 show a better degree of density in parts. In the actual radiographic negative the two dense oxalate stones, Nos. 14 and 15, show small nuclei of poor opacity, and the same features can be made out in Nos. 20, 21, and 26. These points, however, cannot be appreciated from *Fig. 20*.

The poor opacity of all the stones mentioned is due to the presence of uric acid or urate. It is instructive to study *Fig. 21*, in which the nuclei of Nos. 14, 15, 20, and 21 are clearly seen.

The large amount of phosphate present surrounding a nucleus of different composition is seen in Nos. 16, 21, 23, and 25-28. More than 75 per cent of these stones commenced as uric acid or urate stones, and many of them continued to progress largely as such. Whether they all had their origin in the bladder or in the kidney is not known; but No. 5 certainly is of vesical origin, as its nucleus consists of a portion of a needle, clearly seen both

GROUP III.

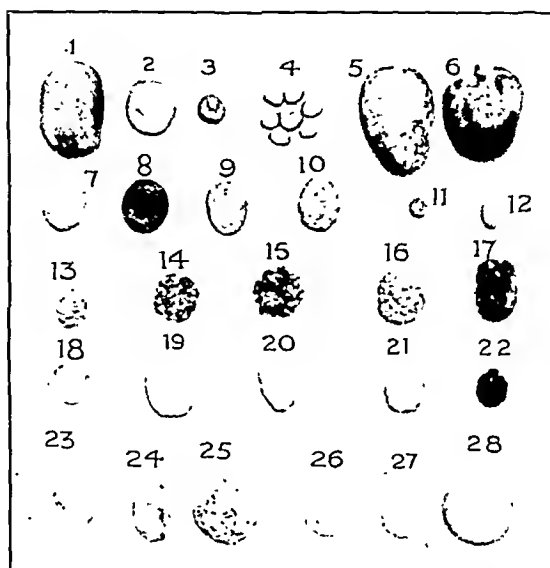


FIG. 19.—A group of vesical calculi. All tend to be rounded or ovoid. Many are covered with phosphatic deposit.

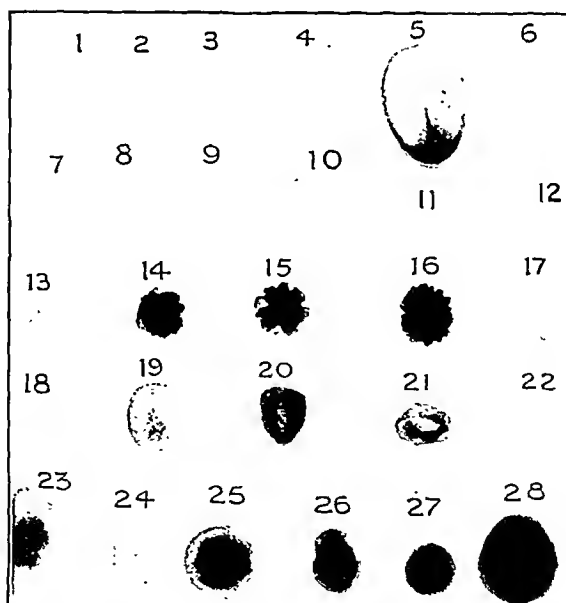


FIG. 20.—Radiogram of the group of stones shown in Fig. 19. Note the complete absence of shadow of many of the calculi, and the poor shadows of others. The poor opacity is due to the large proportions of uric acid and urates. A portion of a needle can be seen forming the nucleus of calculus No. 5.

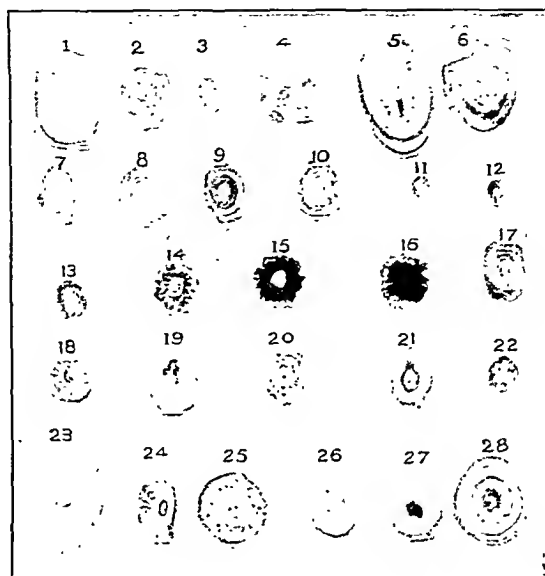
GROUP III, *continued*.

FIG. 21.—Photograph showing internal structure of stones in Fig. 19. The portion of needle can be seen in No. 5. The nuclei of many are well shown by contrast.

in the photograph and the radiogram. The darker portion of the stone indicates the presence of calcium phosphate, part of which was broken off as indicated by the light area.

THE DIAGNOSIS OF CYSTINE STONE.

Cystine and xanthine are worthy of some attention in considering their diagnosis by radiogram. According to the list of molecular weights, cystine lies in density between calcium urate and calcium oxalate. In the radiogram showing the cubes (Fig. 2) which formed part of the investigation, cystine occupies the same place with regard to opacity, but its shadow is much closer in density to that of the urate than to that of the oxalate, although it contains a little calcium. It would be quite wrong to say from this comparison that cystine gives a shadow almost equal in density to that of calcium oxalate. It undoubtedly gives a poor shadow, while the oxalate gives a good one. No doubt the sulphur present in the cystine molecule helps to increase its density.

In the earlier days of radiography it was held that a cystine stone was too transparent to the rays to be visible on a radiogram; subsequently, however, stones containing cystine removed by operation were shown to have been previously demonstrated by radiography. In all of these cases where the stones were submitted to chemical analysis, a certain amount of inorganic

matter, in addition to sulphur sufficient to explain the density, was demonstrated. Henry Morris described a cystine stone in the bladder in a boy of seven. It was easily identified by X rays. Müller quotes a renal case of cystine stone where small cystine recurrences were revealed by radiogram. A phosphatic crust was identified on the stones in these cases. Holmes and Ruggles refer to cystine stone as giving a very dense shadow. Colgate Graves, of Boston, describes a case in which he removed a cystine stone from the pelvis of the kidney. The stone measured 1.7 cm. \times 1.7 cm. \times 1 cm., and was negative to an ordinary X-ray examination. The stone, however, was revealed by pyelography as a less dense area in the middle of a somewhat distended pelvis. There is an excellent illustration of the pyelogram.

There is no doubt whatever that many stones containing cystine show up perfectly well on a good radiogram, but this is due to the fact that calcium is so frequently present. In *Fig. 18* the stone in the right-hand bottom corner is a cystine stone. It throws a very good shadow. It has been labelled cystine oxide. As a matter of fact it contains a fair proportion of calcium as well.

The clinical radiogram of the large cystine stone already discussed (*Fig. 15*) makes an interesting study. By observing the bony skeleton, it will be seen that the radiogram is a good one. The main calculus, which measured 6 cm. in length by 3 cm., is easily identified. In addition there were seventeen other calculi varying in size from a diameter of 1 to 2 cm. It will be seen that the majority of the smaller stones are not visible. The general truth that all big kidney stones can be demonstrated by radiogram is well illustrated. It may be said that only the small pure cystine stones should be difficult to demonstrate.

A comparison between the shadow of the large cystine stone, No. 3, and the oxalate stone, No. 10, in *Group II* is a fairly accurate demonstration of the difference in opacity of these two substances, as the two stones each have an antero-posterior diameter of 3 cm.

SUMMARY.

The relative opacity of calculi of equal depth depends upon the atomic or molecular weights of their constituents.

The opacity of a calculus is determined by: (1) The nature of its constituents; (2) Its structure; (3) Its thickness.

Calcium oxalate and calcium phosphate give very good shadows. They are very common constituents of urinary calculi. The high relative opacity is due to the high atomic weight of the calcium present in these salts.

All the other common urinary salts give relatively poor shadows. They include the urates, uric acid, and triple phosphate.

Cystine and xanthine also give poor shadows in the pure state, but of slightly more opacity than the foregoing owing to the sulphur they contain.

It is rare for any of the foregoing substances to be the sole constituent of a stone. This applies to cystine as well as the more common varieties. There is frequently calcium oxalate or phosphate present.

The figures of different observers giving the relative incidence of different

salts in calculi have frequently been conflicting. Recent observers, however, are agreed upon the preponderance of calcium oxalate in renal and ureteric stones, and of uric acid and urates in bladder stones.

Phosphate is found in larger proportions as a constituent of bladder stone than of renal stone. It frequently surrounds a nucleus of oxalate, or uric acid or urate.

Stones of uric acid or urate in the kidney or ureter soon become mixed with calcium salts, after which they can be identified by radiogram.

Exploratory operation for stone is rarely justified when a radiogram is negative.

Radiograms sometimes fail to demonstrate vesical calculi consisting largely of uric acid or ammonium urate. Where possible, cystoscopy should always be carried out for this reason.

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THE REPAIR OF LARGE ABDOMINAL HERNIÆ BY MUSCLE TRANSPLANTATION.

BY KENNETH MACKENZIE, AUCKLAND, NEW ZEALAND.

FROM the point of view of operative treatment, abdominal herniæ may be divided into two classes: (1) Cases in which, after free dissection, layers of sound fascial and muscular tissue can be sutured to close the gap; (2) Cases in which the defect is too great for the approximation of the margins to be possible, or in which the tissue around the hernia is not competent to bear the strain.

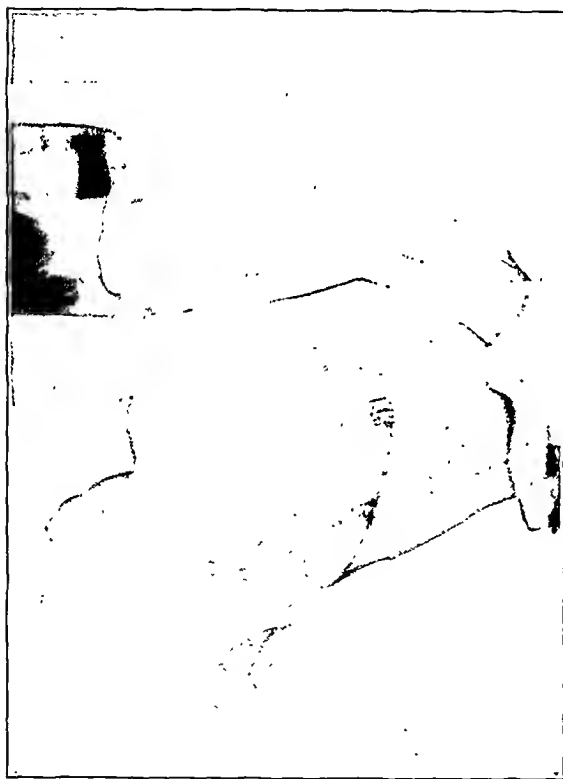


FIG. 22.—Large abdominal hernia; the case before operation.

This second class presents a difficult problem to the surgeon, and many solutions have been proposed. The introduction of the wire filigree was hailed with enthusiasm. It has given many excellent results, but there have also been many failures, either from disintegration of the filigree, or from the occurrence of even that minimum degree of sepsis which is fatal to the success of a metal implantation operation. The trend of surgery is away from the use of such material; hence trial has been made of animal tissue to close the defect. Massive free transplants of fascia lata have been used, or lacings with strips of fascia. For the better nutrition of the transplant, pedicled grafts have been used, especially in the upper abdomen, where large rectangular flaps of fascia have been turned down from the pectoral region. Ramlen-Hansen detached the sartorius muscle from the iliac spine, and carried it across the defect to a higher attachment on the abdominal wall.

My particular problem, for which none of the above methods seemed likely to be adequate, was a man 46 years of age, who received a severe

abdominal wound in the Battle of the Somme in 1916. The intestines protruded; there was much suppuration, and, in spite of numerous operations, fecal fistulæ persisted until 1922. During these years an enormous hernia had developed (Fig. 22). The greater part of the wall of the left lower quadrant of the abdomen had been destroyed, and there was a circular gap, 5 inches in diameter, with its lower margin at Poupart's ligament and its inner margin nearly at the mid-line. The hernia contained almost the whole of the intestines. Many attempts had been made to support it with belts and bandages, but had failed, the more readily as the man had contracted a chronic bronchial affection.

Coaptation of the edges of the gap was out of the question, and it did not appear likely that a passive tissue such as fascia could bear the strain without stretching. A filigree was impossible in a wound in which infection was almost bound to be lurking.

The best chance, it seemed, was offered by the replacement of the abdominal muscle by other muscular tissue. A study on the cadaver showed that the tensor fasciæ femoris was the obvious muscle to use. Its upper attachment to the spine of the ilium is of small size, and this allows of the easy swinging of the muscle. The nervous and vascular supply enter

the muscle very high up, and nerve and vessels, placed near the centre of swinging, are scarcely stretched when the muscle is in its new position. Lastly, the loss of this muscle is of small account to the limb.

The operation was performed under combined spinal and nitrous oxide and oxygen anaesthesia. A large mass of unhealthy skin was removed, and the margins of the opening were defined. The intestines were more readily replaced than had been anticipated. The peritoneal cavity was closed. A long vertical incision was carried down into the thigh. The tensor muscle was dissected free, with a margin of $1\frac{1}{2}$ in. at its lower end and rather less at its lateral borders, special care being taken to preserve the nervous and vascular supply. The muscle was swung forward and upward for a third of a circle, and filled the hernial opening, the fascial fringes overlapping the



FIG. 23.—The same case ten weeks after operation.

adjacent abdominal fascia by fully an inch. The graft was fixed by numerous interrupted sutures of stout chromic gut. The gap in the investment of the thigh was narrowed as far as possible. A large rubber tissue drain was placed in the wound.

During the week after operation there was much trouble with cough. A small infection developed at the pubic corner of the wound, but remained localized and soon cleared up. At the end of a month electrical treatment of the transplanted muscle was commenced. At the end of six weeks the man



FIG. 24.—The same, ten weeks after operation.

was allowed up, and soon regained his activity. At the present time, four months after operation, the abdominal wall is sound, and there is every indication that a permanent cure of the hernia has been achieved. (*See Figs. 23, 24.*)

I suggest that this method can be used for the most advanced types of inguinal hernia, and for certain large post-operative herniæ in the mid-line below the umbilicus, in which the whole lower abdominal wall could be braced up by the use of the tensor muscle of each side, and the suture of their lower borders in the mid-line of the abdomen.

THE NUTRITION OF ARTICULAR CARTILAGE AND ITS METHOD OF REPAIR.

BY LUKE KOKEN ITO, LONDON.

THE NUTRITION OF ARTICULAR CARTILAGE.

HISTORICAL NOTES.

ALTHOUGH Brodie, Bishat, Müller, Liston, and other older surgeons opposed this view, it is now generally acknowledged that articular cartilage in the adult is a non-vascular tissue. In 1742 William Hunter stated: "In the articular cartilage the blood-vessels are so small that they do not admit the red globules of the blood; so that they remain in a great measure unknown until the art of filling the vascular system with a liquid wax brought them to light." "Nor even by this method are we able, in adult subjects, to demonstrate the vessels of the true cartilaginous substance; the fat, glands, and ligaments may be red with injected vessels, while not one coloured speck appears upon the articular cartilage itself." Leidy pointed out the advantages of this non-vascularity of cartilage in securing its immunity from the many accidents to which a vascular tissue would be liable in a similar position where the parts are so much exposed to injury or irritation. Birkett, Redfern, Bart, Béclard, Cruveilhier, Meekel, etc., also believed in the non-vascularity of the articular cartilage.

In the past there were differences of opinion as to whether the free surface of the articular cartilages is invested by a reflection of the synovial membrane or not. Hunter stated that the perichondrium of the smooth articular cartilage is so fine and so firmly attached to the surface that there was "room for doubt whether it has been often demonstrated or rightly understood"; he raised a membrane in fairly large pieces after macerating, and found it to be a continuation of that fine, smooth membrane that lines the capsule of the ligament, folded over the end of the bone from the insertion of the ligament. Leidy failed to detect in the adult the slightest trace of synovial membrane on the free surface of the articular cartilages; he observed, however, that in the foetal state it definitely exists, but after birth, in the progress of growth of the articular cartilages, it appears to be destroyed by pressure and attrition, and probably by the retirement of the surface vessels towards the circumference.

Todd and Bowman also believed that there is no synovial membrane on those parts of the articular cartilage that are exposed to pressure during movements of the joint. Toynebee believed that all healthy articular cartilage is invested with synovial membrane, which, however, differs from that met with elsewhere in that it is deprived of an epithelial layer. In one of Garrod's specimens Toynebee found a gouty deposit on the surface of the

articular cartilage covered by a fine synovial membrane. Henle described a delicate layer of cells (perichondrium) upon the actual free surface of the articular cartilage. Davis, Strangeways, Timbrell Fisher, and others, however, have confirmed the fact that in the main part there is no membrane on the articular cartilage.

In conclusion, it is generally believed that in the adult the lateral area of the articular cartilage is covered with a delicate extension of the synovial membrane; the central area, on the other hand, is completely deficient in any membrane or epithelial layer.

Whence, then, does articular cartilage derive its nutriment?

William Hunter believed that the articular cartilage derives it from the *circulus articulari vasculosus* described by him. Bart stated that in the adult it is principally nourished by fluid exuded from the vessels of the underlying cancellous bone. In adult articular cartilage there can be demonstrated very minute canals, probably for the passage of nutrient fluids that otherwise in this dense tissue would permeate with difficulty. According to Bart, the free surface of the cartilage is nourished by *liquor sanguinis* exuded from the *circulus articulari vasculosus*.

Leidy held the view that, during development and growth, articular cartilage possesses an interstitial nutrition; but that, after the cartilage is fully formed, it is supplied by fluid that osmoses from the vessels beneath its attached surface, and from the *circulus vasculosus* at its circumference, and especially by the synovia upon its free surface; he stated that the synovia is particularly rich in albumin. By experiments on calves, rabbits, and pigeons he found that the articular cartilage is quite capable of imbibing the synovial fluid. Toynbee considered that the chief supply of pabulum came, in the adult, from lymph exuded from the blood-channels of cancellous spaces. Strangeways observed 'loose bodies' in the joints, and discovered by operation that continued enlargement went on for a long time, although the loose bodies were quite detached; he concluded, therefore, that the synovial fluid is an important source of pabulum. Timbrell Fisher concluded that the deeper strata of the articular cartilage are nourished in the manner described by Toynbee, that the central articular area is supplied by the synovial fluid, and that the remainder near the edges receives its nutrient supply from the *circulus articulari vasculosus*. Using Shattock's method of staining mucin pink with carbol-thionin, Timbrell Fisher demonstrated that the zone of matrix of articular cartilage immediately surrounding each cell group is stained pink, and that the pink zones branch and intercommunicate. He considered, therefore, that the articular cartilage receives nourishment from plasma percolating through the network formed by the more mucinous part of the cartilage matrix that surrounds the cell groups.

EXPERIMENTS.

My own experiments, made under the guidance of Mr. Choyce in the Surgical Unit at University College Hospital, are as follows:—

Using rats or rabbits, I opened the knee-joint by an external longitudinal incision, and then removed from the condylar surface of the femur, where

the cartilage is uncovered by any membrane, either one or two pieces of articular cartilage, some with and some without portions of subjacent bone. I then left the detached piece or pieces free in the same joint cavity, and closed the joint by suturing the capsule and skin with human hair which had been sterilized by boiling in water. For comparison, in some cases a piece of bone taken from the tail of the same animal was substituted for the detached cartilage, and the latter was auto-transplanted into the subcutaneous tissue of the animal's back.

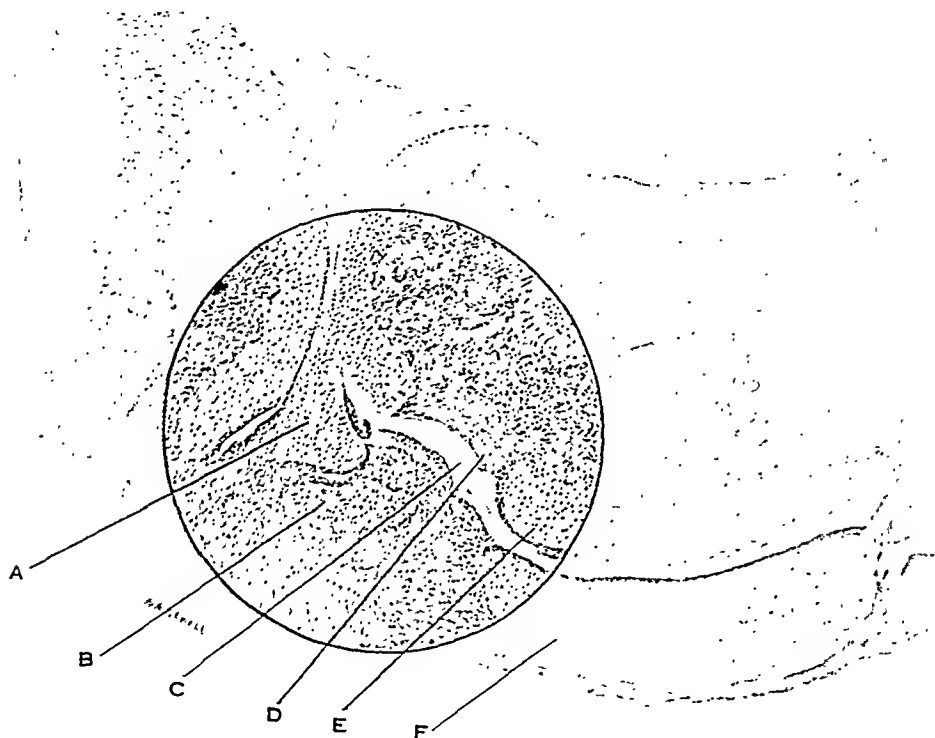


FIG. 25.—(Experiment 35). Examination 11 days after operation. A, Intra-articular cartilage; B, Loose body; C, Joint cavity; D, Defect of articular cartilage; E, Articular cartilage (original); F, Patella.

In another series of experiments a fresh whole knee-joint was transplanted into another animal of the same species; in still another a caudal vertebra together with its neighbouring joint was transplanted into the animal's back. The results of these control experiments will be reported later.

The results were observed after intervals that varied from one to fifteen weeks. The rats used were mostly young, or young adults, and approximately of the same age. Each specimen was fixed in 10 per cent solution of formaldehyde or Zenker's solution, decalcified in 5 per cent solution of nitric acid, followed by 1 per cent solution of sodium carbonate, and then thoroughly washed in running water. It was then embedded in paraffin

or celloidin and stained with Mallory's eosin-methylene-blue or alum-haematoxylin-eosin.

Only a few of the typical results are here described :—

I. EXPERIMENT NO. 35.—Rat : age 45 days, male.

Method.—Rigid asepsis. Ether anaesthesia. Piece of articular cartilage detached from condylar surface of femur and left free in the joint cavity.

Examination 11 Days after Operation.—The detached cartilage was found in the synovial membrane between the anterior end of the intra-articular cartilage and

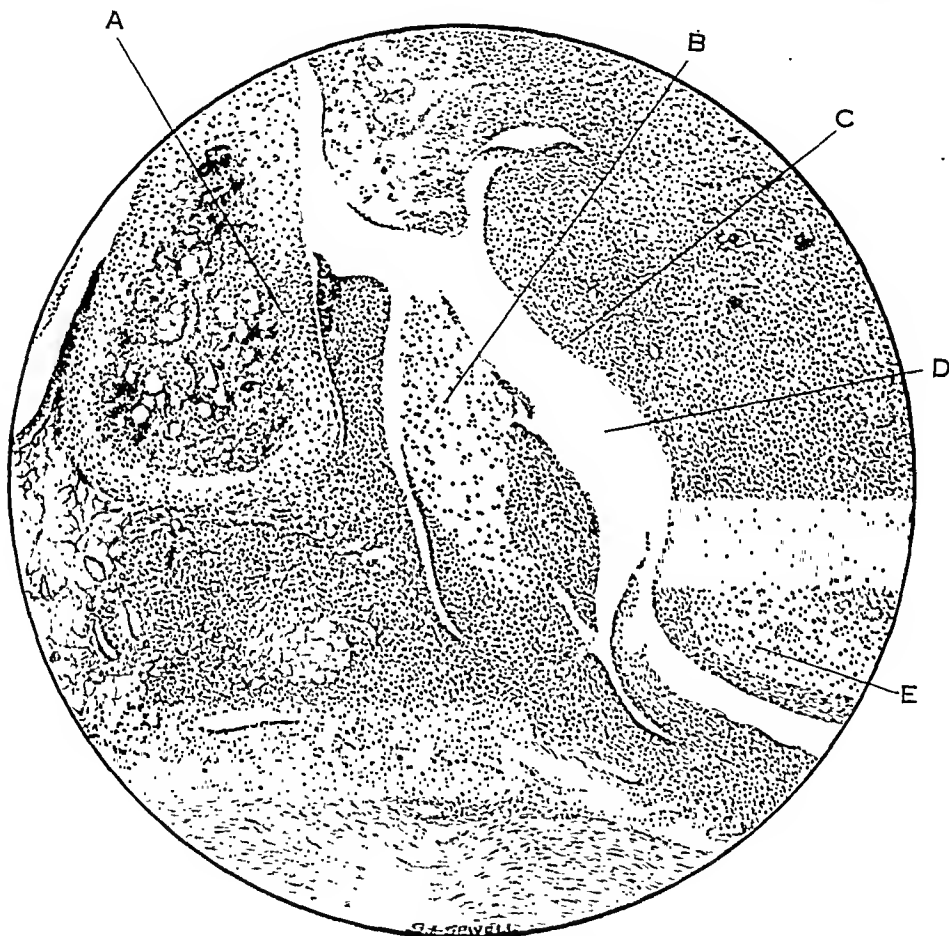


FIG. 26.—(Experiment 15). Examination 3 weeks after operation. A, Intra-articular cartilage ; B, Loose body ; C, Defect of articular cartilage ; D, Joint cavity ; E, Newly-formed cartilage.

the patella. It had become entirely surrounded by fibrous tissue, and the cartilage-cells had retained vitality, for they stained fairly well. No proliferative activity was seen. In this case no bone tissue had been detached. The defect on the condylar surface, caused by removal of the piece of cartilage, was found to have become lined with a layer of fibrous tissue, which intruded, more or less, into the bone-marrow. The bony tissue just below this fibrous tissue had lost activity, the bone-cells staining either badly or not at all. (Fig. 25.)

II. EXPERIMENT No. 15.—Rat : adult, male.

Method.—As in No. I, but with the detachment of some bone with the fragment.

Examination 3 Weeks after Operation.—The piece of cartilage was found partly wrapped in synovial membrane, and lying between the patella and the anterior part of the intra-articular cartilage ; nearly half of it faced the joint cavity, and was free from covering membrane. The cartilage-cells in it stained well, but no bone-cells could be found, alive or dead. The cartilage defect in the femur was abundantly covered with fibrous tissue which contained many newly-formed blood-vessels ; some fibroblasts were also seen scattered in the bone-marrow. In this fibrous tissue there was an area of newly-formed cartilaginous tissue. In the bony tissue around the injured area a little of the bone had lost its bone-cells. (*Fig. 26.*)

III. EXPERIMENT No. 31.—Rat : very young female.

Method.—As in No. II.

Examination 6 Weeks after Operation (Fig. 27).—In this case a detached piece of cartilage was found in connective tissue in the anterior part of the joint, near the patella. Not only had the original cartilage retained its vitality, but newly-formed cartilage could be seen. On the other hand, the bone-cells that had been detached with the cartilage had disappeared. The defect in the femoral cartilage was mostly covered with fibrous tissue, but in part with a tissue intermediate between cartilage and fibrous tissue, and to a small extent with a newly-formed cartilaginous tissue.

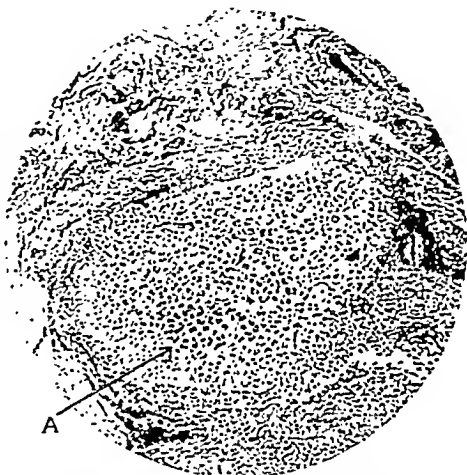


FIG. 27.—(Experiment 31). Examination 6 weeks after operation. A. Loose piece of cartilage in joint, near patella.

IV. EXPERIMENT No. 24.—Rat : young female.

Method.—As in No. II.

Microscopical Examination 7 Weeks after Operation.—The detached fragment

was found half covered with synovial membrane, and half projected, uncovered, into the joint cavity. Both bone and cartilage-cells in it stained well. The femoral defect was repaired, in some part with newly-formed cartilage and in part with fibrous tissue ; moreover, some tissue, transitional between cartilage and fibrous tissue, was seen. (*Fig. 28.*)

V. EXPERIMENT No. 23.—Rat : adult female.

Method.—As in No. II.

Microscopical Examination 8 Weeks after Operation (Fig. 29).—A fragment was located in the synovial membrane, partly attached to it and partly projecting free into the articular cavity. The cartilage-cells stained well : the original bone-cells had disappeared, but a slight new formation of bone-tissue could be found. The femoral defect was covered with a tissue that was mostly homogeneous, and no newly-formed cartilage could be seen.

VI. EXPERIMENT No. 18.—Rat : young male.

Method.—As in No. II.

Microscopical Examination 12 Weeks after Operation (Fig. 30).—The detached fragment was slightly surrounded with fibrous and fatty tissue derived from the synovial membrane, and lay just under the patella. The cartilage-cells in it showed staining activity fairly well, but their proliferative activity was doubtful. The

femoral defect was covered with a thin layer of fibrous tissue, directly covering the subjacent bone ; no cartilage could be seen in it.

VII. EXPERIMENT No. 20.—Rat : adult female.

Method.—As in No. II. This rat gave birth after operation.

Microscopical Examination 13 Weeks after Operation (Fig. 31).—The detached fragment was found in the popliteal part of the joint ; it had become pedunculated

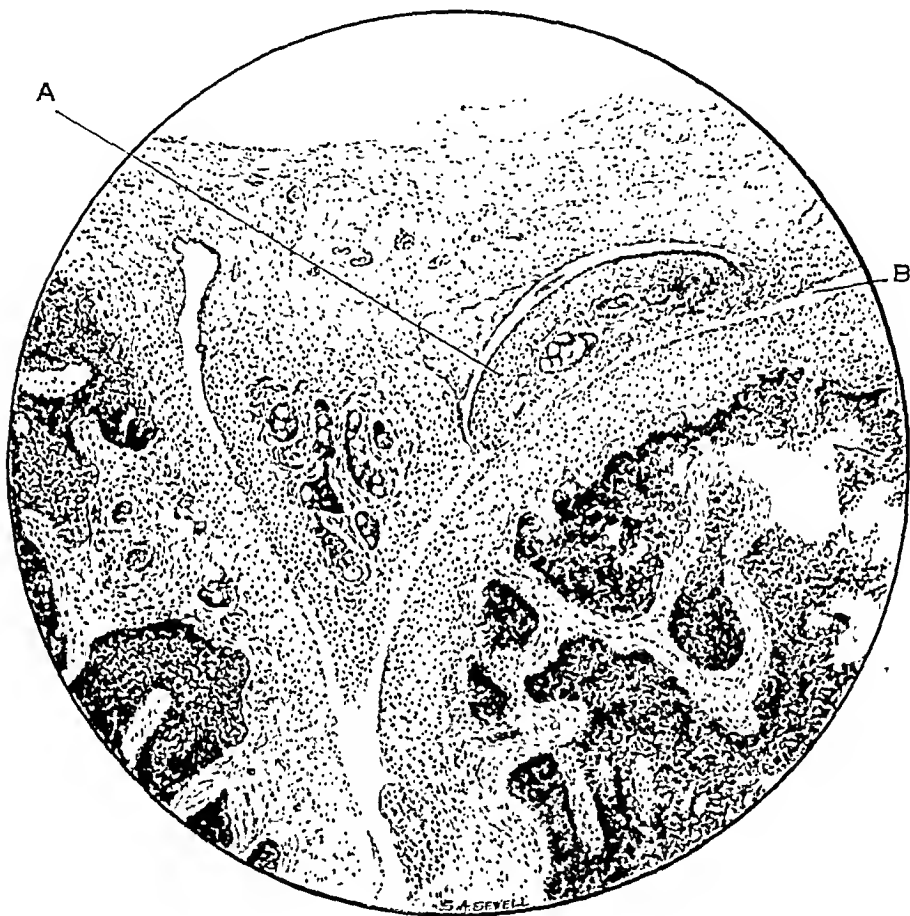


FIG. 28.—(Experiment 24). Examination 7 weeks after operation.
A, Loose body ; B, Joint cavity:

to the synovial membrane, and its whole mass had become covered with one or two layers of fibrous-tissue cells. Both cartilage-cells and bone-cells in the fragment stained well, though they were quite slight. The femoral defect was repaired with homogeneous tissue, newly-formed cartilage, and fibrous tissue.

VIII. EXPERIMENT No. 34.—Rabbit : young male.

Method.—As in No. II. Two pieces were detached.

Gross Finding 4 Weeks after Operation.—On opening the joint, two fragments were found. One was free in the joint cavity, the other was completely wrapped in synovial membrane. The former was smoothly rounded, almost oval-shaped,

and of the size of a rice grain; the latter had maintained its original irregular form. A few drops of synovial fluid escaped; in appearance it was indistinguishable from that of the healthy side. The defect in the articular cartilage of the femur showed piling up with a whitish, dense mass; no adhesion was found.



FIG. 29.—(Experiment 23). Examination 8 weeks after operation. A, Joint cavity; B, Interarticular cartilage; C, Loose body in synovial membrane.

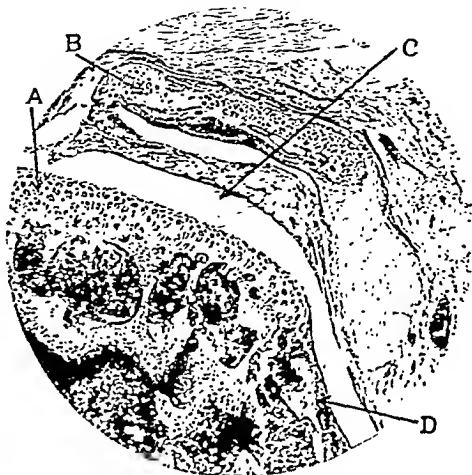


FIG. 30.—(Experiment 18). Examination 12 weeks after operation. A, Articular cartilage (original); B, Loose body; C, Joint cavity; D, Defect of articular cartilage.

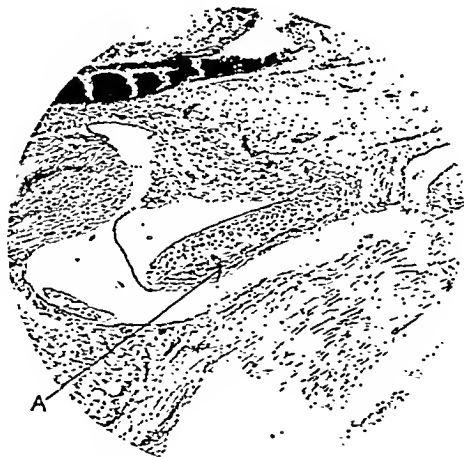


FIG. 31.—(Experiment 20). Examination 13 weeks after operation. A, Loose body.

Microscopical Examination (Figs 32-35).—

a. The fragment that was free in the joint: this was covered with thin layers of fibrous tissue. The original cartilage had maintained itself, but in certain places the cartilage-cells stained feebly and were of lowered vitality, and also there was well-marked new cartilage proliferation. The old bone-tissue had nearly lost its

bone-cells, but slight new bone-formation could be seen. The bone-marrow consisted mostly of fatty cells and red blood-corpuscles.

b. The fragment that had gained an attachment to synovial membrane: this was completely buried in the synovial membrane. In it the newly-formed bone-tissue was rather abundant, and the old bone, which had lost its bone-cells, was in small amount. The cartilage-cells stained well, but no evidence of new proliferation could be found. A small mass of dead bone, isolated from the above fragment, was detected in the fibrous tissue. The defect in the femur was repaired with the following structures: the superficial layer consisted of strongly developed fibrous tissue cells; the middle zone of tissue transitional between fibrous tissue and cartilage; and the deepest layer, in contact with the subjacent bone, was composed of

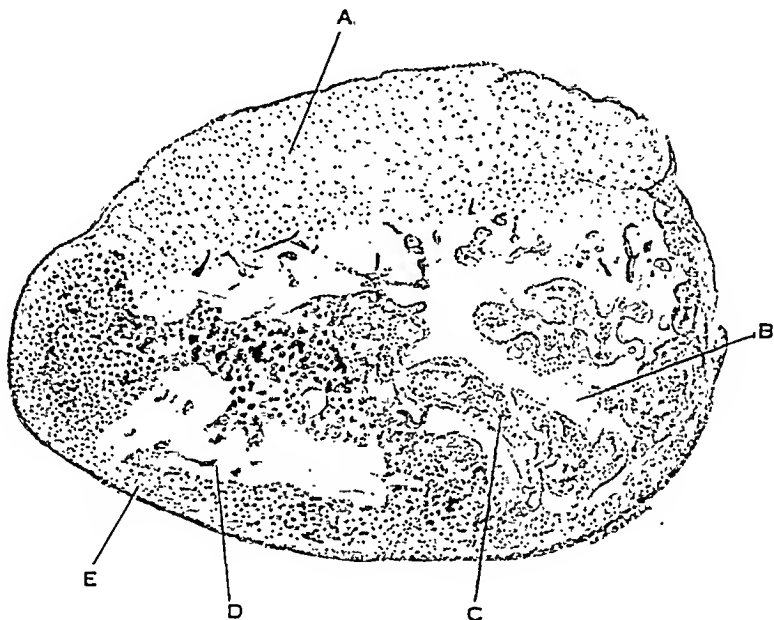


FIG. 32.—(*Experiment 34*). Young male rabbit: the completely detached loose body, 4 weeks after operation. A, Original articular cartilage; B, Newly-formed bone; C, Bone-marrow; D, Dead bone; E, Newly-formed cartilage.

newly-formed cartilage-cells. The bone-tissue just below the above structure showed proliferative activity better than in any other part. The whole repaired zone, at its greatest thickness, was nearly four times thicker than the surrounding undamaged articular cartilage.

SUMMARY OF ALL THE EXPERIMENTS, INCLUDING THOSE NOT DESCRIBED HERE.

Microscopical Examination.—The cartilage-cells in the loose bodies mostly retained vitality, and many proliferated; the bone-cells, on the contrary, became inactive and died; this agreed with Timbrell Fisher's results, and I believe that cartilage tissue is always more persistent than bone-tissue. After four weeks, however, newly-formed bone-tissue appeared round the dead bone in the loose bodies; this finding is confirmed by other experiments in which I transplanted pieces of the tails of rats, including bone and cartilage, into

animals' backs, and showed that, in almost all cases, new bone appeared after two weeks. As was expected, proliferative activity appeared greater in the younger than in the older animals.

With one exception the loose bodies were found to have gained a definite

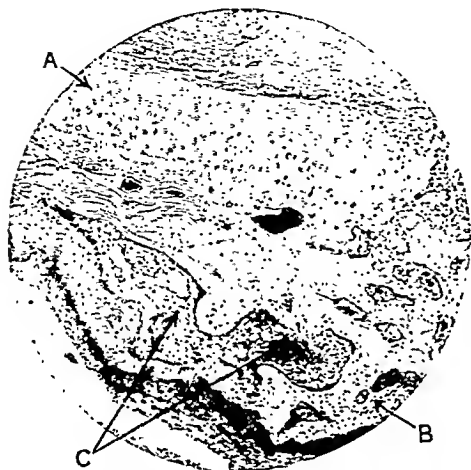


FIG. 33.—(*Experiment 34*). Examination 4 weeks after operation. A, Articular cartilage (original); B, Newly-formed bone; C, Bone-marrow.

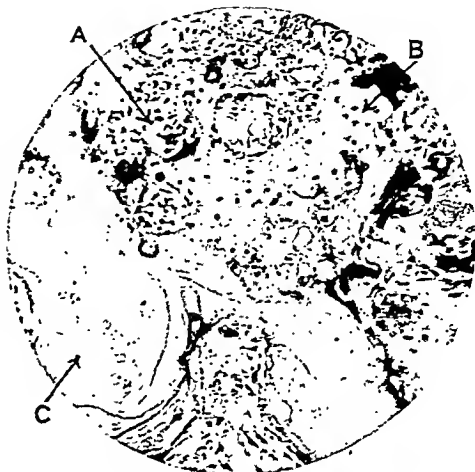


FIG. 34.—(*Experiment 34*). Examination 4 weeks after operation (higher magnification than Fig. 33). A, Bone-marrow; B, Newly-formed bone; C, Dead bone.

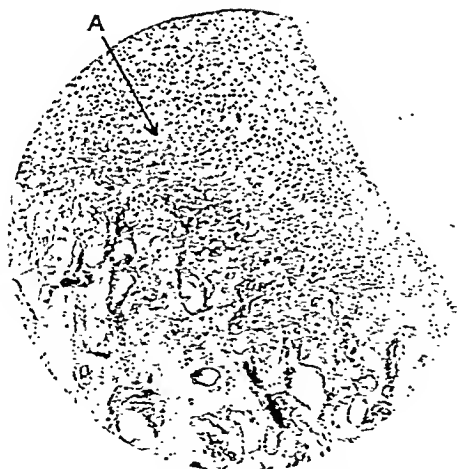


FIG. 35.—(*Experiment 34*). Examination 4 weeks after operation. The defect was filled with tissue and newly-formed cartilage. A, New cartilage.

attachment to the synovial membrane: some were almost embedded in it, others were affixed by edges and the whole of one surface, whilst still others had secured a pedunculated attachment. Some bodies that had been set free in the joint could not afterwards be found even by careful search. In

one ease (a rabbit) only was the loose body found wandering free in the joint cavity; it had retained its activity. Most of the 'loose' bodies were found to have localized themselves in the synovial membrane of the anterior part of the joint, under or near the patella; one had become pedunculated in the popliteal space. The free one in the rabbit was particularly interesting, because, if it be assumed that it had remained free all the time between operation and post-mortem, it seems to prove that a piece of cartilage separated from all supply of pabulum except that derived from the synovial fluid can not only live but can proliferate; its bone elements had nearly disappeared, but there was slight new bone-formation; its cartilage had clearly proliferated. The question might justifiably be raised as to whether this loose body had been loose throughout the whole period between operation and post-mortem, or whether, like the others in my series, it had secured an attachment, which in this case had later been lost, so that the body again became loose. But careful examination of this body showed no evidence of any past attachment; its surfaces were uniformly smooth and showed no sign of the remains of a torn pedicle. It is therefore fair to assume that probably no such attachment had existed, or that, even if it had, the secondary separation had not been recent. As the cartilage-cells were quite active and there was some slight rejuvenescence of bone, vitality must have been active right up to the time of the animal's death, in spite of a separation that must have lasted much, if not all, of the time since operation.

Most of the other loose bodies had secured attachments to synovial membrane in the anterior parts of the joint, near the patella, though one was pedunculated in the popliteal space. These anterior parts of the joint are probably backwaters into which the loose body is worked during movements of the joint; in the small animals used, the relatively large loose bodies became jammed into these backwaters, and therefore, becoming motionless, there had an opportunity of securing attachment. If larger animals had been used, the loose bodies could have been cut relatively smaller; such smaller bodies would have had wider range of movements, would have been less liable to become trapped in corners, and would probably have remained free in a greater number of cases; it may be noted that the persistently free loose body was found in the only rabbit used; all the other animals were rats or mice.

The supposition that the completely loose body found in my rabbit had been nourished by the synovial fluid is, I think, a fair one, whether it is supposed that complete detachment had persisted since operation, or whether we believe that there had been a temporary attachment that had ruptured; moreover, it is in agreement with Strangeways' cases. The question whether the fluid was normal or not is not, however, so clear. Neither in my own nor in Strangeways' cases was an analytical comparison made between the synovia of the joint with loose body and its fellow without one. Timbrell Fisher's suggestion is that the loose body may cause sufficient synovitis to enrich the protein content of the synovia. However, the joint mouse in my rabbit was so relatively small and smooth and rounded that it probably caused but little trauma; and the synovia at post-mortem exhibited no difference in quantity, colour, or viscosity from that of the corresponding joint of the other limb; its total quantity was too small for analysis.

My experiment, therefore, is confirmatory of the belief that synovia can nourish loose articular cartilage; it may be presumed, therefore, that it has some nutritive function for unloosened articular cartilage, and that it may be an important factor in the nourishment of the superficies of cartilage near the centre of a joint, far removed from both circulus vasculosus and underlying cancellous bone.

REPAIR OF ARTICULAR CARTILAGE.

In my experiments the incisions for the removal of the pieces of articular cartilage all went through the thickness of the cartilage. The operative condylar defect so made healed by granulation tissue that became fibrous: this tissue invaded the underlying bone. Sometimes (e.g., *Experiment No. 34*, rabbit) it formed a heaped-up mass more than filling the gap. The tissue filling the gap in this case showed three zones, viz., fibrous on articular face, middle zone of intermediate tissue, and deepest zone of new cartilage cells. In another experiment (*No. 37*) cartilage was very freely formed.

EXPERIMENT No. 37.—Rat: age 45 days, male. *Method.*—Knee-joint opened; piece of articular cartilage, together with a portion of underlying bone, removed from the condylar surface of the femur.

Examination 4 weeks later (Fig. 36).—The defect was found to be smoothly filled with a whitish dense mass; there were no adhesions. Microscopic examination showed that the whitish mass largely consisted of newly-formed cartilage, but its surface was covered with fibrous tissue; there was also fibrous tissue between the new and the adjacent original cartilage. This new cartilage also protruded for a short distance into the subjacent bone-marrow; the development of new bone beneath it was insufficient.

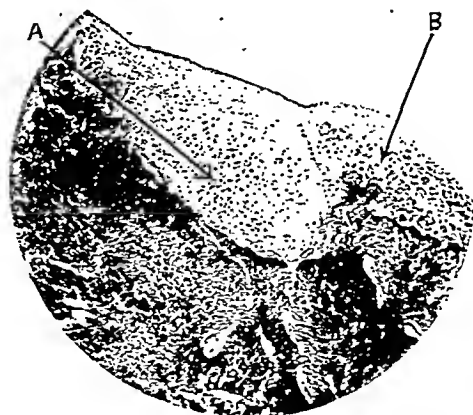


FIG. 36.—(*Experiment 37*). 'Examination 4 weeks after operation. A, Newly-formed cartilage; B, Articular cartilage (original).

To sum up: The gap at first becomes filled with granulation tissue, which becomes fibrous, then fibro-cartilaginous, then cartilaginous. The time required for the formation of the cartilage varies: thus, *No. 37* showed complete repair in the 4th week: *No. 34* showed overgrowth by the same date: on the other hand, in some cases the repair material was still fibrous, without cartilage formation, as late as 12 weeks after operation.

Commonly in the rat the defect is filled with fibrous tissue by the end of the first week: after two weeks there is tissue transitional between fibrous tissue and cartilage, and after three weeks there are islets of new cartilage in the fibrous tissue. In some, the new cartilage was separated by fibrous tissue from the original cartilage, e.g., *No. 37*; in others it was continuous.

In the rabbit (*No.* 34) three zones, fibrous, transitional, and cartilaginous, were definite.

In some specimens it appears that the reparative tissue has come from the underlying cancellous tissue, in others transitional cartilage-like tissue seems to arise in connection with the edges of synovial membrane, if the injury to the articular cartilage has approached them. Redfern and Timbrell Fisher have shown that repair near the margins is good, but that nearer the centre it is poor, unless the underlying cancellous tissue has been exposed.

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A NOTE ON EXTERNAL DUODENAL FISTULA: WITH A RECORD OF SOME UNPUBLISHED CASES.

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AN external duodenal fistula is a much-dreaded sequel to disease of, or injury to, this portion of the alimentary tract. It is fortunately of somewhat infrequent occurrence. A recent paper on this subject (Cameron¹), with a review of the literature, refers to 30 cases, but there are doubtless many others unpublished. The writer of this article has had personal experience of 4 cases which have been in his surgical ward at the London Hospital during the last twenty years, and, from the hospital records during that time, a further 3 cases have been found, which have been placed at his disposal by the kindness of his surgical colleagues. One of the writer's cases (*Case 1*) has only recently left the hospital, and this short paper is based largely on the experience gained from this patient.

Etiology.—As one might expect, the majority of external duodenal fistulae result from operative procedures, either upon the duodenum itself or on neighbouring viscera, especially the gall-bladder and kidney. Traumatic rupture of the duodenum (other than by a shot wound) is rare, and 'war' injuries have not been considered in this paper.

An analysis of 30 cases reported in Cameron's paper (*loc. cit.*) shows the etiology of the condition as follows:—

DUODENAL FISTULA RESULTING FROM:—

Operation on the duodenum for—	Cases		Cases
a. Perforation of ulcer ..	6	Operation on the gall-bladder ..	6
b. Traumatic rupture ..	5	Operation on the kidney ..	7
c. Gall-stone in common bile-duct	1	Operation on the stomach ..	2
d. Carcinoma of the pancreas	1	Abscess in the loin	1
		Cause uncertain	1

The etiology of 7 cases occurring in the London Hospital surgical wards during the last twenty years is as follows:—

DUODENAL FISTULA RESULTING FROM:—

Operation on the duodenum for—	Cases		Cases
a. Perforated ulcer	1	Operation on the stomach ..	2
b. Acute diverticulitis	1	Operation on the kidney ..	1
c. Traumatic rupture	1	Operation for appendix abscess ..	1

It appears from this short series that the majority of fistulae in the duodenum are a direct result of operation for diseases of the duodenum itself (8 cases), of the right kidney (8 cases), or of the gall-bladder and bile-ducts, of which 7 examples are recorded; direct injury to the duodenum, treated by operation, is responsible for 6 cases, whilst operation on the stomach (4 cases), on the duodenum (cholecyst-duodenostomy) for carcinoma of the pancreas (1 case), appendix (1), abscess in the loin (1), and unknown cause (1), make up the remainder.

An external duodenal fistula occurring spontaneously, as a result of perforation of an ulcer and abscess formation, is very rare. One case has been recorded (Moynihan²).

It is significant that in the majority of these operations, as pointed out by Cameron, *gauze packing* was frequently used in addition to tube drainage.

Diagnosis.—The diagnosis of duodenal fistula depends upon the discharge from the wound of the characteristic duodenal fluid. This is usually bile-stained, but to a variable degree. It is viscid, alkaline in reaction, and may be discharged in enormous quantities. The amount discharged, however, varies considerably. It is difficult to measure the amount unless some form of permanent drainage apparatus is employed. In Cameron's case, quoted above, 700 c.c. were recorded daily, whilst in another patient (Erdmann³), no less than 4000 c.c. were collected in one day; subsequently, 50 to 60 oz. were discharged daily for eight days, after a jejunostomy had been made. It is easy to realize what a severe drain this must be on a patient enfeebled by a recent operation. On the other hand, the discharge in some recorded cases has been almost insignificant.

Next in importance to the actual amount is the irritating character of the discharge, and this again varies greatly. In some cases irritation of the surrounding tissues is hardly noticeable, whilst in others it is intense. Extensive burning of the skin, which causes agonizing pain, occurs, so that the constant dressings become almost unbearable.

Symptoms.—The symptoms caused by a duodenal fistula depend entirely on the amount and character of the discharge. In the ultra-acute cases, the rapidity with which a patient goes down-hill is most striking, and immediate operative treatment is urgently called for. Even the less acute cases, on account of the loss of sleep owing to pain, and progressive weakness from the constant dehydration, demand active surgical treatment if life is to be saved. In marked contrast are those where the discharge is scanty, does not irritate the tissues, and the symptoms are merely due to the discomfort of an occasional dressing.

Prognosis.—The accepted teaching that a duodenal fistula is an exceptionally grave lesion is mainly correct; but it is surprising to note how many have healed up, either with simple local treatment or as the result of some form of operation. Thus, in the 30 cases recorded in Cameron's paper, there were 18 recoveries. In 7 treated at the London Hospital between 1902 and 1923, recovery took place in all, and in 5 of these, healing of the fistula occurred without operation.

Prognosis as to the probable *duration* of the discharge depends on the amount and character of the fluid. Records show that, in the acute cases, death may occur in two or three days; in the less severe, discharge of fluid may cease after several weeks. In one remarkable case at the London Hospital (*Case 5*), under the care of my colleague, Mr. Russell Howard, an intermittent duodenal discharge had persisted for eleven years!

Treatment.—The treatment of a duodenal fistula depends upon the amount and character of the discharge and its effect upon the general condition of the patient. Operative treatment should not be considered at first unless urgent symptoms demand it. Local and general treatment alone may suffice.

LOCAL TREATMENT.—This consists in protecting the skin and, if possible, in some way preventing the discharge from coming into contact with the surrounding tissues. An ointment of oxide of zinc and castor oil, spread on lint, is useful; liquid paraffin has been successfully used in some cases. It is better not to employ either gauze or tube drainage. As the discharge is alkaline, acid solutions have been tried, but with little success and great discomfort to the patient.

Suction of the fluid has been employed with good results (Erdmann, Cameron). Cameron employed an electrical suction apparatus, but the constant noise of such an instrument prevents its employment in a general hospital ward. Erdmann drew off the discharge into a sterile bottle connected with a suction apparatus, and fed his patient through a jejunostomy opening with the duodenal secretions collected by this means! An ingenious frame, which enabled this to be done, is figured in an account of this case (*loc. cit.*).

A constant dilution of the discharge was successfully carried out in one case (Cheever), sterile water being used.

Cameron refers to two successful cases treated by Einhorn by means of his duodenal tube, but there are obvious limitations to this method.

GENERAL TREATMENT.—This consists in withholding fluid by the mouth as far as it is possible. Injections of saline and glucose should be administered by the rectum, and atropine may also be given as a means of lessening the amount of pancreatic secretion.

OPERATIVE MEASURES.—In the severe cases, some form of operation is imperative, in order to enable the patient to receive fluid, and so make up for the severe dehydration resulting from the continual discharge. The choice of operation rests between: (1) Gastro-enterostomy combined with occlusion of the pylorus (Berg⁴); (2) Jejunostomy; (3) Direct suture of the opening in the duodenum combined with either (1) or (2); (4) Direct suture alone.

1. *Gastro-enterostomy with Occlusion of the Pylorus.*—As treatment of a duodenal fistula, this was first suggested and performed by Berg. In 6 published cases, 4 recovered after this treatment: an immediate cessation of discharge followed in 3 cases. In the writer's patient (*Case 1*), the discharge decreased gradually for five days, and then a rapid improvement took place.

This treatment aims at cutting off the discharge of all stomach contents into the duodenum, thus removing the stimuli which encourage the flow of bile and pancreatic secretions. It has the great advantage that, within a few hours after operation, the patient can be given plenty of fluid naturally, and, after twenty-four hours, nourishment such as milk, eggs, Benger's food, etc. The chief disadvantage is that, in the already exhausted condition of the patient, such an operation may not be tolerated. Two cases reported by Berg proved fatal, although the discharge was efficiently checked. Another disadvantage is the obvious undesirability of short-circuiting a healthy stomach, a proceeding which may give rise to unpleasant sequelae.

If Berg's method of treatment depends mainly on occlusion of the pylorus for its undoubted value in checking the duodenal discharge, it is difficult to explain how a duodenal fistula with much discharge can occur after a partial gastrectomy with closure of the first part of the duodenum. In Cameron's case (treated by suction) profuse duodenal discharge occurred after an anterior

Polya operation for cancer, and the careful record of this case seems to indicate that the discharge did come from the duodenum. A duodenal fistula (after partial gastrectomy) must be a very rare occurrence: notes of two cases only (Walton) were found in the London Hospital records up to date; they are included in the list at the end of this paper. The alternative hypothesis, that the fistula arose at the site of the anastomosis, is difficult to disprove, but is highly improbable.

2. *Jejunostomy*.—This operation, as an alternative method of introducing fluid, has much in its favour. It can be performed rapidly under local anaesthesia, and by improved methods in technique the fear of a permanent jejunal fistula should be negligible.

The choice of operative treatment usually rests between one or other of these methods.

3. *Direct Suture of the Opening Combined with Gastro-enterostomy and Closure of the Pylorus*.—One successful case (Souttar⁵) was operated on by this method at the West London Hospital in 1913. The patient, a girl, age 14, was admitted with a subhepatic abscess which was opened and drained; a duodenal fistula followed the operation. Nine days later a second operation was performed; an opening was found in the second portion of the duodenum; this was closed by sutures. The pylorus was infolded by Lembert sutures, and a posterior gastro-enterostomy made. The operation was completely successful. The duodenal ulcer was probably the result of a severe burn sustained by the patient eighteen months previously.

4. *Treatment by Direct Suture alone* is tempting, but the results have not been encouraging. Mayo achieved a brilliant success in one case, but the operation was done immediately after the discharge was noticed, and probably the deleterious effect of the tryptic fluid on the tissues was not established. In all the other reported cases the sutures subsequently gave way, and this cannot be wondered at when one has observed the intense irritation to which the tissues are subjected.

ANALYSIS OF RESULTS.

Table I.—SIMPLE LOCAL TREATMENT: 13 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Mayo ..	2 weeks	Died
2	Mayo ..	5 days	Died
3	Mayo ..	2 weeks	Died
4	Gardner ..	1 month	Recovered
5	Davis ..	12 days	Recovered
6	Palmer ..	8 days	Recovered
7	Hendon ..	5 weeks	Recovered
8	Stadler ..	1 month	Recovered
9	Author (Case 2)	3 months	Recovered
10	Author (Case 3)	1 month	Recovered
11	Author (Case 4) Operation by Huddy ⁶	11 days	Recovered
12	Walton (Case 6)	9 days	Recovered
13	Walton (Case 7)	5 weeks	Recovered

Recovered, 10 cases; died, 3 cases.

Table II.—SUCTION TREATMENT: 3 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Palmer Irrigation	10 days	Recovered
2	Cameron ..	11 days	Recovered
3	Cheever Irrigation and Syrphonage	Soon stopped ..	Recovered

Recovered, 3 cases.

Table IV.—BERG'S OPERATION: 6 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Berg ..	Ceased at once	Died: exhaustion
2	Berg ..	Ceased at once	Died: shock
3	Cameron ..	Ceased almost immediately	Recovered
4	Knaggs ..	Marked improvement ..	Recovered
5	Thénevard ..	Not stated	Recovered
6	Author (Case 1)	Immediate improvement, discharge ceased after 5 days	Recovered

Recovered, 4 cases; died, 2 cases.

Table V.—JEJUNOSTOMY: 5 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Esau ..	Not noted	Died in 6 days from exhaustion
2	Winewarter ..	Not noted	Died 2 days after
3	Pannett ..	Short time	Recovered
4	McGuire ..	Immediate improvement, and closure in 3 weeks ..	Recovered
5	Erdmann + Suction	10 days	Recovered

Recovered, 3 cases; died, 2 cases.

Table VI.—DIRECT SUTURE (ALONE OR IN COMBINATION): 4 CASES.

CASE		DURATION OF DISCHARGE	RESULT
1	Mayo ..	Stopped at once	Recovered
2	Souttar + Berg's Opn.	Stopped at once	Recovered
3	Koerte ..	Sutures gave way 2 days later	Died
4	Fruwaengler + Berg's Opn.	Suture line leaked ..	Died

Recovered, 2 cases (1 simple suture); died, 2 cases.

CASES FROM THE LONDON HOSPITAL RECORDS.

Case 1 (AUTHOR).—Traumatic rupture of duodenum; duodenal fistula.

E. W., male, age 18. In October, 1923, the patient was playing Rugby football, was tackled, and fell forward on to the boot-heel of another player who was lying on the ground; the heel struck the patient in the epigastric region, and at the same time another man fell on his (patient's) back. He was helped up, but became unconscious for a few minutes. His abdomen was rubbed and he was able to walk off the field with help. He was sick, bringing up a little blood-stained mucus. When examined, an hour later, the pulse was 88. There was a bruise present over the upper part of the right rectus: no rigidity of the abdominal wall: no dullness in the loins: liver dullness present. Patient complained of severe spasmodic pains, and vomited repeatedly, chiefly mucus. He found lying on the right side the most comfortable position. His condition two hours later (7 p.m.) was much the same: there was no marked local rigidity or tenderness; still sickness; still spasmodic pain; $\frac{1}{2}$ gr. morphia given.

At 9 p.m. the pain was much better and vomiting had ceased. Well-marked bruise in the upper part of the right rectus, which now seemed somewhat rigid. Patient slept until 3 a.m., when the vomiting and pain recommenced.

Next day, at 10 a.m., the patient was found to have rigidity in the right side of the abdomen. Temperature 101° ; pulse 100.

FIRST OPERATION.—At 1 p.m., Mr. Robert Going, F.R.C.S., of Littlehampton, opened the abdomen by a vertical incision to the right of the middle line, from the 'ensiform' to just above the umbilical line. The right rectus was retracted, and the posterior sheath opened. Later, to obtain more room, the rectus was divided transversely at the lower part of the incision. When the abdomen was opened, no free fluid was noticed at first. Emphysema was present in the gastrocolic omentum. The gall-bladder was full and adherent: some old adhesions between the gall-bladder and stomach were ligatured and divided. The gall-bladder was apparently intact. The first part of the duodenum was then examined. After separating some adhesions, what looked like a tear was found in the posterior peritoneum, close to the outer side of the second part of the duodenum; this was enlarged, and then a *small perforation in the duodenal wall* was seen: this was sutured, and the peritoneum and omentum were then sutured over it. The stomach was normal, the jejunum distended, the transverse colon normal and empty. Some bile-stained fluid was found in the right iliac region; this was swabbed out. A drainage tube was passed down to the renal pouch through a 'stab' opening in the right lumbar region. The lesser sac of the peritoneum was then explored: no fluid was found in it.

The patient became much collapsed, and the operation was finished quickly. The abdominal wall was sutured in layers. Patient rallied after a saline infusion: he had some post-anæsthetic vomiting. At 10 p.m. the pulse could be counted and was more regular.

Next day, Oct. 29, patient was much better: some bile-stained fluid escaped from the drainage tube: there was no abdominal distention. Patient improved during the day: the pulse became quite regular and he retained rectal saline injections.

Oct. 30. Patient steadily improved: no vomiting. Nutrients were given four-hourly and were retained: a small quantity of water was given by the mouth.

Oct. 31. General condition improving: had some feeds of milk and albumen-water.

Nov. 4. As the drainage tube appeared to be blocked, a stitch was removed and the tube altered in position: finally, it was removed and found to be blocked by a slough. A quantity of bile-stained fluid then came away: there was some infection of the incision in the right rectus. The bowels acted after an enema. In the evening a large quantity of fluid came away and escaped through the dressings.

Nov. 5. There was continued discharge from the tube: a large quantity of dark-coloured, viscid fluid escaped: this irritated the skin of the right flank, which

was deeply injected and acutely painful. The patient's general condition had changed for the worse. His eyes were sunken and he appeared much exhausted.

Nov. 6. Patient was sent up in an ambulance to the London Hospital, and seen by the writer the same afternoon, 6 p.m. The patient was evidently extremely ill. His eyes were sunken, his hands cold, and he was much exhausted. The tongue was dry and thickly coated. He did not complain of pain except when the wound was dressed. Below the ribs, in the right lumbar region, was a sinus with a drainage tube in it. The skin was intensely excoriated round this, over an area extending back in the right loin nearly to the spine: a large quantity of gelatinous-looking and slightly bile-stained fluid escaped. The dressings were continually soaked.

Temperature on admission 97°: pulse 100, small, very low tension; respirations 30. Rectal salines with glucose were ordered. As the patient was much exhausted by the long journey, it was decided to postpone operation until the next morning.

SECOND OPERATION, Nov. 7, 1923 (by the author).—The old incision was re-opened. Many adhesions were found to the right side of the abdomen: these were not interfered with. The stomach and first part of the duodenum appeared normal.

A posterior, no-loop, gastrojejunostomy was rapidly made, and the pylorus was then occluded by a purse-string suture of silk. A feed of beaten-up egg and peptonized milk was given (into the jejunum) at the time of the operation.

Nov. 8. The patient's condition was much the same, but he had rallied well from the operation: there was a little post-anæsthetic vomiting. He was able to take some fluid by the mouth; saline and glucose were given per rectum at intervals.

Nov. 9. The fistula was still discharging considerably: the skin round the orifice was raw and acutely painful: the dressings were soaked and required to be changed three times during the day and four times at night. He was taking a good amount of fluid by the mouth; at one time there appeared to be a little milk in the fluid escaping from the fistula.

Nov. 10. Patient propped up in a sitting position. He was looking better: his eyes less sunken. There was still a considerable discharge from the fistula, but patient was taking more fluid by the mouth, and also beaten-up egg, jelly, custard, etc. The skin was still very sore right round to the spine, although kept covered with emollient dressings. The discharge was alkaline, probably mainly pancreatic fluid.

Nov. 11 (4th day). Discharge appreciably less.

Nov. 12. Dressed only twice during the night; much less discharge on each dressing.

Nov. 13. Discharge quite slight: a very little thin fluid. Skin much less sore and inflamed: only one dressing required through the night.

Nov. 15. The patient's general condition was vastly improved. The eyes were not sunken, and he was sleeping and taking his food well. There was a very little discharge from the fistula: only one dressing was required every twelve hours. The skin round the fistula was rapidly healing.

Nov. 22. Fistula practically dry. From this date, patient made an uninterrupted recovery. The transverse portion of the abdominal incision gaped, but healed firmly by granulations.

Dec. 7. The patient was discharged from the hospital. Wound healed; general condition quite satisfactory. Pulse 82, temperature normal. Bowels acting normally.

He is in sound health at the present date.

Case 2 (Author).—F. H., female, age 39. A nephrectomy was performed at the London Hospital in 1910, for right pyonephrosis. The wound was drained for a time: it healed up slowly, and the patient left hospital two months later; she went to a convalescent home. Two days afterwards she complained of dragging pain in the right side, and vomited. The wound was opened up at the home; this

was followed by a sudden discharge of gas and a copious flow of thick yellow fluid tinged with green. Patient was re-admitted to hospital. The skin was much ulcerated and painful, and there was a free discharge of duodenal fluid from the wound. At one time, portions of an egg which had been eaten were found on the dressing. The discharge gradually became watery: it continued for two months and then ceased spontaneously. Her general condition at one time gave rise to anxiety. Treatment consisted in frequent dressings, and emollients for protection of the skin.

Case 3 (AUTHOR).—A. D., male, age 15. A case of appendix abscess, operated upon at the London Hospital in 1907. A large abscess of ten days' duration, tracking upwards towards the right kidney, was opened and drained with two tubes and gauze. The lower end of the kidney was palpable at the time of operation. The appendix could not be removed. The tubes and gauze were removed three days after operation, when a copious discharge of thin, sour fluid, containing bile, took place. The fluid irritated the skin: this continued for five days, and necessitated frequent dressings. The patient's general condition remained good, the discharge gradually lessened, and had completely ceased three weeks after operation.

Case 4 (AUTHOR).—Female, age (?). This case of acute diverticulitis of the duodenum was reported in the *Lancet*, 1923.⁶ Operated on by Mr. G. P. Huddy, Surgical Registrar at the London Hospital. An inflamed and partly gangrenous diverticulum was found in the second portion of the duodenum, and was excised. Three days after operation, a discharge of brownish, watery fluid occurred. This was never profuse; the patient's condition gradually improved, and the wound healed fourteen days after operation. There was never any appreciable irritation of the edges of the wound.

Case 5 (MR. RUSSELL HOWARD).—G. B., male, age 66. A patient at the London Hospital in 1913. He had been operated on for a subhepatic abscess eleven years previously. A duodenal fistula, containing bile, resulted, and this had continued ever since. His general health was never much impaired, but the skin was always somewhat inflamed and the discharge was, at times, copious: it varied considerably from time to time. The patient at times plugged the wound and checked the discharge. When admitted to hospital, the patient was in good condition; the skin round the fistula was inflamed; the amount of discharge was not excessive, as the dressings had only to be changed three or four times a day.

Operation by Mr. Russell Howard. The abdomen was opened and a fistula was found opening into the first part of the duodenum. The duodenum was separated from the abdominal wall, and the opening closed by sutures. The abdominal wound was then repaired. The operation was completely successful.

The interesting features of this case are the duration of the discharge, and the ease with which the operation was performed; there was a surprising absence of adhesions in the operation area.

Case 6 (MR. A. J. WALTON).—H. S., male, age 54. This patient was operated on in the London Hospital in 1921 for carcinoma of the stomach. A partial gastrectomy was performed. The patient made a good recovery and left the hospital three weeks after operation. Next day a discharge occurred from the wound and he was re-admitted. There was a free discharge of alkaline, bile-stained fluid. Local treatment was adopted, and the discharge, which had never been excessive, ceased spontaneously nine days later. There was some irritation of the surrounding skin. The patient's general condition was good, and he is, at present, in sound health.

Case 7 (MR. A. J. WALTON).—C. S., female, age (?). Operated on at the London Hospital for a lesser-curve carcinomatous ulcer of the stomach. Partial gastrectomy was performed. The growth was adherent to the mesocolon. Twenty-three days after operation, a fistula developed, which persisted for five weeks. The discharged

fluid was bile-stained, faintly acid in reaction, and contained pus and coliform bacilli. The fistula slowly healed up. The patient was discharged from hospital in fair condition, but has since failed to report at the 'follow up' department.

CONCLUSIONS.

1. A duodenal fistula is a serious, but by no means fatal, condition.
2. In the less severe cases, simple local treatment may be tried.
3. In the acute cases, operative treatment is urgently called for, the choice lying between Berg's method and a jejunostomy.
4. Some form of suction apparatus is of much value from the nursing point of view, and adds greatly to the comfort of the patient.

I have drawn largely from Dr. Angus Cameron's excellent paper and careful record of the literature of this subject. My thanks are also due to Mr. Hamilton Bailey, F.R.C.S., my chief assistant at the London Hospital, for valuable help in the preparation of this paper.

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TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD, AND RELATION OF TRAUMA TO PSEUDOCOXALGIA:

ANALYSIS OF 59 CASES PUBLISHED UP TO JANUARY, 1924.

By C. C. CHOYCE, LONDON.

THIS condition is very rare, having only been previously recorded on fifty-three occasions, but attains interest because in several recent cases sequels have occurred many months after the primary accident. In two cases definite pseudocoxalgia has followed (Elmslie and Rehbein), although radiograms taken

at the time of the accident showed normal shape of the acetabulum and femur; in a third the sequel was rarefaction of the femoral neck and subluxation of the head (Higgins). Elmslie and Rehbein both suggest that the changes in the femoral epiphysis are due to loss of the vascular supply that should accompany the ligamentum teres, of necessity ruptured by the accident. The condition, therefore, becomes interesting from the points of view of prognosis and of a suggestion as to a factor in the production of pseudocoxalgia. It seems worth while, for these reasons, to record a recent



FIG. 37.—Traumatic dislocation of hip. Radiogram taken before reduction.

case and to make a short analysis of previously reported ones. It is my intention to follow up my patient systematically with a view to the discovery of sequelæ. The accompanying table contains every case in the literature that I have been able to find, fifty-three in all; it also includes my own recent case, and five others collected from the surgical case-books of University College Hospital.

My own case is that of a boy (Harold B.), age 6 years, who during play endeavoured to carry on his back another boy, age 12. He was unable to bear the weight, his legs straddled, and the two boys fell, the elder and

heavier being on the top. A week later, on May 25, 1923, he was seen by Dr. Lightfoot, who diagnosed dislocation of the hip and sent the patient to hospital. He showed all the classical signs of a dorsal dislocation of the left hip; radiography confirmed the diagnosis and showed no signs of any concomitant fracture (*Fig. 37*). Reduction, under light anæsthesia, was readily accomplished by the usual manœuvres: traction, slow adduction, followed by outward circumduction and by rapid extension of the limb. An X-ray picture taken the next day showed that the head of the femur was in the acetabulum, and that there were no evidences of any damage to the epiphysis of the femoral head or any other abnormality. Movements of the hip, in bed, were free and painless. When I saw the boy six weeks later, the hip still appeared normal. He walked and ran without a limp, passive movements were free and painless in all directions, and a radiogram showed no abnormality. I have recently seen him again, on Jan. 10, 1924. He runs and walks freely without limp or pain. A radiogram (*Fig. 38*) shows no definite abnormality, though the outlines of acetabulum and femoral head are not quite so sharp-cut as in some pictures.



FIG. 38.—Traumatic dislocation of hip. Radiogram eight months after reduction.

Analysis of the reported cases reveals the following points:—

1. **Rarity.**—Only 59 cases are recorded. Maffei states that of 1842 hip luxations observed at the Rizzoli Institute of Bologna since 1901, there were only 3 traumatic dislocations in childhood.

2. **Sex.**—Males. 42; females. 16; not stated, 1.

3. **Age.**—From 11 months to 16 years (an old-standing case). Average about $7\frac{1}{2}$ years.

Ages				Cases	Ages				Cases
Between	0 and	3	..	2	Between	11 and	13	..	6
..	3 and	5	..	6	..	13 and	15	..	8
..	5 and	7	..	13	..	15 (an	old-standing	..	1
..	7 and	9	..	12	..	case)	..	..	1
..	9 and	11	..	10	Not stated	..	..	..	1

4. **Side.**—Right, 22; left, 27; not stated, 10.

5. **Variety of Dislocation.**—Iliac (dorsal). 40; obturator, 7; sciatic, 6; suprapubic, 3; not stated, 3.

RECORDED CASES OF TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD. Up to January, 1924.

No.	NAME OF SURGEON	JOURNAL	SEX	AGE, YEARS	SIDE	TYPE	DURATION BEFORE TREATED	METHOD OF REDUCTION	FINAL RESULTS AND NOTES
1	Bartels ..	<i>Arch. f. klin. Chir.</i> 1874, xvi	?	1½	L.	Iliac	1 day	Manipulation ..	?
2	Bartels ..	Ditto ..	F.	14	R.	Iliac	?	Spontaneous reduction whilst being carried	?
3	Volkmann ..	<i>Deut. Zeits. f. Chir.</i> 1893, xxxvii	M.	13	L.	Iliac	13 weeks	Manipulation failed; femur broken	Hip ankylosis followed
4	Klee ..	<i>Brun's Beiträge z. klin. Chir.</i> 1889, iv	F.	8	R.	Iliac	3 days	Manipulation ..	?
5	Klee ..	Ditto ..	M.	14	L.	Sciatic	2½ months	Manipulation failed	?
6	Helferich ..	<i>Deut. med. Woch.</i> 1893, No. 32	M.	1½	L.	Iliac	24 hours	Manipulation ..	?
7	Helferich ..	Ditto ..	F.	4	L.	Iliac	14 days	Manipulation failed. Reduced by open operation	'Ideal'
8	Volkmann ..	<i>Deut. Zeits. f. Chir.</i> 1893, xxxvii	M.	9	R.	Iliac	7 weeks	Manipulation failed. Open operation; reduction	'Ideal' in 9 months
9	Drehmann ..	<i>Brun's Beiträge z. klin. Chir.</i> 1896, xvii	M.	7	R.	Iliac	3½ weeks	Manipulation after extension with weights	Good in a month
10	Drehmann ..	Ditto ..	M.	8	L.	Iliac	4 weeks	Manipulation only apparently succeeded. Dislocation persistent after removal of plaster. Open operation. Epiphysis found separated. Relaxed and reduction made	Walking with stick at end of 4 weeks
11	Endlich ..	<i>Arch. f. klin. Chir.</i> 1898, lvi	M.	5	L.	Iliac	Old date	Open operation ..	Good 1 year, and still good 4 years after
12	Endlich ..	Ditto ..	M.	9	L.	Obturator	9 weeks	Open operation: reduction, but not stable. 2nd operation 2 months. Sequestrum formation in femoral head and necrosis of cartilage	3 years later: 'satisfactory'
13	Schoemann	Quoted by Doelle in <i>Arch. f. klin. Chir.</i> 1921, exviii, 725	F.	7	L.	Obturator	?	Resection of hip ..	?
14	Cripps, Law-	Ditto ..	F.	4½	R.	Obturator	1½ months	Reduced by manipulation ..	?

RECORDED CASES OF TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD—continued.

No.	NAME OF SURGEON	JOURNAL	SEX	AGE, YEARS	SIDE	TYPE	DURATION BEFORE TREATED	METHOD OF REDUCTION	FINAL RESULTS AND NOTES
32	Weil ..	Ref. <i>Zentralb. f. Orthop.</i> 1910 ..	M.	11	L.	Suprapubic	?	Manipulation ..	Good
33	Weil ..	Ditto ..	M.	?	?	Iliac	?	Non-reduction of hip. Osteotomy to correct position	?
34	Rischieth ..	<i>Lancet</i> , 1914, April 18	M.	10	?	?	?	Reduced by manipulation ..	Good. Walking in 28 days
35	Platt and von Mengershausen	<i>Lancet</i> , 1916, Jan. 8	M.	6	L.	Iliac	1 hour	Ditto	Walking in 1 month
36	Courtillot et Lombard	<i>Rev. Orthop.</i> 1911, v, 477	F.	3½	R.	Iliac	70 days	Ditto. Redirection after 10 days. Reposition	Cure
37	Karenke ..	<i>Munch. med. Woch.</i> 1907	M.	13	L.	Sciatic	1½ hours	Reduced by manipulation ..	Good
38	Ritter (Doelle)	Ditto ..	M.	11	R.	Iliac	24 hours	Ditto	Ditto
39	Ritter (Doelle)	Ditto ..	M.	11	R.	Sciatic	2 hours	Ditto	Very good
40	Maffei ..	<i>Chir. d. Org. del Movimento</i> , 1922, vi, 619	M.	9½	R.	Suprapubic	2½ years	Partial removal of femoral head and osteotomy of the femur	Ultimately satisfactory function
41	Maffei ..	Ditto ..	M.	13	R.	Iliac	5 months	Reduction by open operation ..	Good function after 1½ months
42	Maffei ..	Ditto ..	M.	6	L.	Iliac	48 hours	Reduction by manipulation ..	Perfect function after 2 months
43	Mouchet et Seguinot	<i>Rev. d'Orthop.</i> 1910	M.	16	L.	Iliac	11 years	Operation refused	Good
44	Mouchet et Seguinot	Ditto ..	M.	9	R.	Iliac	Recent	Reduction by manipulation at the second attempt	Good
45	Roderer ..	Quoted by Maffei	M.	10	L.	Iliac	6 years	Operation refused	—
46	Roello ..	<i>Chir. d. Org. del Movimento</i> , 1922, vi, 115	F.	5	R.	Sciatic	Several hours	Reduced by manipulation ..	Complete return of function
47	Roello ..	Ditto ..	M.	6	R.	Sciatic	A few hours	Ditto (Kocher's method)	Perfect function in 12 days

done to him the following:

	Steinke	..	Quoted by Maffie	M.	10	R.	Iliac	Recent	Ditto ..	Good result
49	Steinke	..		M.	10	R.	Iliac	A few hours	..	1 year later was readmitted with the clinical and radiographic picture of Perthes' disease. (Rehbein suggests that it is due to injury of blood-vessels in ligamentum teres) ?
50	Rehbein	..	<i>Deut. Zeits. f. Chir.</i> , 1922, clxxxiv, 416	M.	8	R.	Iliac	A few hours	Easily reduced by manipulation. Radiograph showed normal-shaped head. Left hospital in 2½ weeks without any disability	
51	Murphy, D. P.	..	<i>Jour. Amer. Med. Assoc.</i> , 1923, lxxxv, 549	M.	8	L.	Iliac	A few hours	Easily reduced by manipulation under ether	
52	Higgins, T. T.	..	<i>Proc. Roy. Soc. Med.</i> (Surg. Sect.), 1920-21, xlv, 42	M.	8	R.	Obturator	?	Aug., 1919: Reduced by manipulation. Plaster case. Femoral head and neck normal as seen by X rays	In a few months developed limp. Nov., 1920: Radiograph shows rarefaction of femoral neck; epiphysis well formed. Some subluxation of head of femur upwards and backwards followed 1 year later by pseudo-coxalgia
53	Elmslie	..	<i>Jour. Orthop. Surg.</i> , 1919, I, 109	M.	4	L.	Iliac	8 days	Feb., 1914: Reduced by manipulation. X ray then showed normal-shaped head, now in acetabulum again	
54	Choyce, C. C.	..	Personal case	M.	6	L.	Iliac	7 days	May 25, 1923: Reduced easily by Bigelow's manipulation under amesthesia	Running and walking freely six weeks later; radiogram then showed apparently normal hip. 8 months later (Jan., 1924): No abnormality; runs and walks freely

RECORDED CASES OF TRAUMATIC DISLOCATION OF THE HIP IN CHILDHOOD—continued.

No.	NAME OF SURGEON	JOURNAL	SEX	AGE, YEARS	SIDE	TYPE	DURATION BEFORE TREATED	HISTORY, AND METHOD OF REDUCTION	FINAL RESULTS AND NOTES
55	Collected by C. C. Choyce	Surgical case notes, University College Hospital, London	M.	6	R.	Iliac	1 day	July, 1897. Climbing on a board, which fell with him. Reduced by manipulation	Left hospital in one week; walking well. No subsequent history — not traced
56	Ditto ..	Ditto ..	M.	8	L.	Iliac	1 day	Nov., 1898. Fell when carrying another boy on his back. Reduced by manipulation under chloroform	Went out of hospital in 4 days in Thomas's hip splint. Subsequent history not noted—not traced
57	Ditto ..	Ditto ..	F.	4	R.	Iliac	2 days	1889. Fell from sister's arms. Easily reduced by manipulation under ether	Double Thomas's hip splint. Subsequent history not noted — not traced
58	Ditto ..	Ditto ..	M.	6	?	Iliac	1 day	1888. Pushed over from behind by another boy. Reduced by manipulation under chloroform	Thomas's hip splint. Left hospital on 4th day. Subsequent history unknown
59	Ditto ..	Ditto ..	M.	11½	L.	Iliac	1 day	1887. Tripped and fell with legs widely separated	Left hospital on 16th day—able to walk. Subsequent history unknown

6. Method of Reduction.—Manipulation, usually under anæsthesia, was successful in all cases in which it was tried within fourteen days from the date of the dislocation. In one of Helferich's cases (an iliac dislocation) it failed on the fourteenth day, and resort was had to open operation; the same was true of Hirsch's case. On the other hand, manipulation was successful as late as seventy days after dislocation in Courtillet and Lombard's case of iliac dislocation in a girl of $3\frac{1}{2}$; redislocation occurred ten days later, but reposition resulted in cure. The cases requiring operation ranged in duration from fourteen days to two and a half years; two later cases (six years and eleven years' duration) refused operation. Various operative measures were adopted: the most satisfactory route of access appears to have been by subperiosteal detachment of muscles from the great trochanter, or by detachment and subsequent fixation of the trochanter. In some cases operative clearance of the acetabulum and reposition of the femoral head was successful; in others resection of the femoral head was adopted.

7. Results.—Late results are seldom mentioned, especially in the earlier cases, the recorder being content to state the results as good, ideal, etc. In recently reported cases, however, several late sequels have been reported; it is reasonable, therefore, to believe that had the earlier cases been followed up the results would have been found to be less ideal than was supposed. Thus, in Elmslie's case limping began eleven months later and the condition progressed to one of pseudocoxalgia. Again, in Rehbein's case there were well-marked signs of pseudocoxalgia twelve months later. Both Elmslie and Rehbein suggest that the subsequent changes are due to tearing of the ligamentum teres and interference with the vessels running in it, which take a more important share in the nourishment of the femoral head in childhood than later, when the epiphyseal plate of cartilage between head and neck is less complete. In Higgins' case, too, late changes appeared in the head and neck; fifteen months after the accident there was limping, and a radiogram showed rarefaction of the femoral neck, and, although the epiphysis remained of good shape, there was some subluxation of the head of the femur upwards and backwards. It would appear advisable, therefore, to give a guarded prognosis as to ultimate changes; limping is apt to recur after a period of about a year, and pseudocoxalgia and similar changes may then be found.

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DOELLE, *Ibid.*, 1922, cxviii, 703: 39 cases up to date.

MARTINI, *Chir. d. Org. del Movimento*, 1922, vi, 619.

(The above contain references to 49 cases collected from the literature. I add the following 5 cases, making a total of 54 recorded up to January, 1924.)

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THE ETIOLOGY OF THE FEMORAL HERNIAL SAC.*

By J. PHILIP BUCKLEY, MANCHESTER.

I AM about to express opinions which I have been developing since 1911, and regarding which I have in succeeding years become more and more confident. My conclusions are based largely on clinical and operative observations. I purposely refrain from commencing the consideration of this subject by trying to show how it is that femoral hernia is more common in women than in men. It confessedly occurs quite commonly in males but more commonly in females. If we approach the subject by discussing why this is the case, there is a danger that our clear vision may be fogged when we come to consider, as I intend to do, why in a given case of femoral hernia, whether in a male or in a female, that hernia has developed.

In discussing the subject I must first briefly recall a few anatomical details of a simple kind; then I shall enumerate the various types of femoral hernia met with clinically; thirdly, I shall mention existing theories and attempt to disprove them; and finally my own views will be given. As an appendix, a few words will be added about the relative frequency in the sexes.

Anatomy.—Femoral hernia develops in the potential space between the femoral vein and the free edge of Gimbernat's ligament. On the inner side of this so-called crural ring is the resistant, sharp edge of Gimbernat's ligament; on the outer side is the collapsible femoral vein, whose collapsibility is somewhat masked in the normal unherniated subject by some fibrous tissue loosely attached on the one hand to Poupart's ligament, and on the other hand to the horizontal ramus of the pubis; anteriorly the ring is bounded by the resistant Poupart's ligament, and deeply by the horizontal ramus of the pubis covered by the pectineus muscle and fascia. On the abdominal side of the ring is peritoneal fat in direct continuity with what is known as the cribriform fascia, which is simply a tough fibro-fatty plug occupying the crural ring. The peritoneal fat, situated at the angle between the anterior abdominal wall and the brim of the true pelvis internally, and the wing of the ilium externally, is loose, easily stretched, and in some considerable quantity. Deep again to this fat is the peritoneum, itself loose and stretchable and having a definite adhesiveness to the peritoneal fat, so that when the one is pulled upon, the other is dragged with it. Superficially to the crural ring is the loose connective tissue of the thigh.

The Various Types of so-called Femoral Hernia met with Clinically.—I say 'so-called', because, accepting the definition of an abdominal hernia as a protrusion of an abdominal viscus through the parietes, we find that not all loosely called femoral herniæ do actually hold contents.

* Paper read before the Manchester Surgical Society, April, 1923.

1. *Uncomplicated Herniæ.*—

a. A protrusion of properitoneal fat through the crural ring, expanding into the connective tissue of the thigh, covered by and definitely demarcated from the thigh fat by a smooth, thin, delicate fascia. It forms a soft, defined, subcutaneous mass in the upper part of the thigh, easily felt on palpation but not very obvious on mere inspection, and containing no peritoneal sac.

b. Commoner than the first type, but resembling it clinically in every way, and only differing from it in that it is usually larger, and that in the midst of the fatty mass is a definite but empty peritoneal sac in direct continuity with the general peritoneal cavity by means of a very narrow neck, through which it is difficult to squeeze even the first joint of the little finger, but which is easily and permanently stretched by inserting the closed blades of a pair of Spencer Wells' forceps and opening them. This feature explains why mention has been made of the presence of some fibrous tissue on the outer side of the neck of the sac, which masks the collapsibility of the femoral vein.

c. A similar type of peritoneal sac covered by a thick layer of properitoneal fat, but containing omentum. This, in my experience, is the commonest type. In virtue of its contents it is larger and more conspicuous than the second type, and its neck is wider, being stretched by the omentum passing through it.

d. The sac is larger, and its properitoneal covering is thinned by the expansion of the sac secondary to the increase in the amount of the contents. It usually contains omentum only, but in an old hernia in which the neck has been very widely stretched bowel may, but in my experience uncommonly, occupy the sac without being strangled.

Here I feel I must call attention to a statement in a well-known textbook on surgery,¹ because it is so contrary to my own experience. It says: "Femoral herniæ are less liable to contain omentum than the inguinal variety; a portion of the ileum is most often present". It may be acknowledged that in cases which are operated on for strangulation the strangulated viscus is almost always the ileum: but surely the contents of an uncomplicated femoral hernia are in the large majority of cases omentum.

2. *Complicated Herniæ.*—

a. Strangulation of properitoneal fat in the variety where there is a fatty sac without contents. I have seen one case of this type where suddenly the properitoneal fat with its contained sac was forced down, with the formation of a tense swelling, which was tender to the touch, but was accompanied by no vomiting and practically no shock. On exposure, the fatty sac had a faint mottled purple colour due to the passive hyperæmia. This case was admitted to the Manchester Royal Infirmary as an 'urgence'.

b The type where omental contents have become strangled.

c. The type where a knuckle of bowel has been forced through the narrow neck of the sac and become strangulated. Sometimes only a portion of the lumen of the bowel is involved, producing the partial enterocele of Richter. Usually in neither of these forms does the bowel occupy the whole sac, and this fact, of course, strongly supports the theory of a pre-formed sac.

THEORIES OF SAC FORMATION.

Having mentioned the various types of femoral hernia, which later will be seen to be of importance in the development of my theory, I shall now proceed to state and briefly criticize the existing theories. These, as far as I am aware, are two in number: (1) That which Murray² refers to as the 'orthodox teaching'; and (2) That of Hamilton Russell,³ which he calls the 'saccular theory'. The latter theory was strongly supported by Murray.

1. The Orthodox Theory.—The so-called orthodox theory holds that the sac of a femoral hernia develops contemporaneously with the extrusion of the viscus. Thus, to quote from Gray's *Anatomy*:⁴ "When a portion of intestine is forced through the femoral ring it carries with it a pouch of peritoneum, which forms the hernial sac".

Now I maintain, and I think the supporters of Russell's 'saccular theory' do so too, that this theory is quite put out of court by the fact that we frequently meet with those cases mentioned above of an empty sac, richly covered with properitoneal fat and having a very narrow neck. When we meet with such cases at operation it is to my mind obvious that they have never held any contents, because, firstly, if the contents had been passive omentum, that omentum would have been held so tightly at the neck that it would never have been possible for it to have returned into the abdomen and it would soon have acquired adhesions at the neck, a condition which is almost always found to exist when omentum is present in the sac; secondly, if the contents had been bowel, that bowel must have been strangulated by the narrow neck, which condition would have manifested itself by symptoms of strangulation and obstruction. Again, when we come across cases of strangulated gut in a femoral sac, that gut is almost always smaller than the sac itself, and this alone strongly suggests that the sac has been a pre-existing one.

2. The Saccular Theory.—Hamilton Russell defines his theory thus:⁵ "The theory rejects the view that hernia can ever be 'acquired' in the pathological sense, and maintains that the presence of a developmental peritoneal diverticulum or sac is a necessary antecedent condition in every case of ordinary abdominal hernia".

Murray explains this theory, as applied to femoral hernia, fully and with care in his book *Hernia, its Cause and Treatment*. In criticizing the theory, I propose to follow his line of thought as expressed in this book. He says:⁶ "It is then surely reasonable to believe that a crural gubernacular attachment, developed in excess of the normal, may, without producing an abnormal descent of the testicle, drag upon the peritoneum sufficiently to make a dimple in the crural region, which, with the growth of the individual, will develop into a potential hernia sac". As I understand it, this means that the crural attachment of the gubernaculum, excessively developed, arches round the external pillar of the external ring of the inguinal canal, reaches the groin, and, burrowing up between the femoral vein and Gimbernat's ligament, attaches itself to the peritoneum, and by muscular or cicatricial contraction drags down that peritoneum to form the sac of a potential femoral hernia.

Murray supports Russell's theory as follows. He mentions a case, described

by Macready in his *Treatise on Ruptures*, where three femoral sacs were present.⁷ "one in the usual position of a femoral hernia, a second peritoneal sac had traversed Gimbernat's ligament, and a third protruded over and to the outer side of the femoral artery". Murray says,⁸ "the fact that three diverticula were found in close proximity is in favour of the developmental view", and adds,⁹ "that view receives support from their shape, for it is distinctly stated that the abdominal entrance of both these pouches was narrower than the fundus. Had these diverticula been produced by the bowel pushing the peritoneum in front of it, then the mouth of each sac would have been wide". The first of these reasons seems to give no valuable support to the theory. The second statement is true, but does not seem exclusively to support the congenital theory. It seems only to exclude the 'orthodox' theory.

Murray notes¹⁰ that Macready, referring to persons seen at the City of London Truss Society during 1888, 1889, and 1890, records 22 cases of femoral hernia in males under 15 years of age, and 42 in females; but he does not mention that these were taken from a total of 461 males on the one hand, and of 1197 females on the other; nor does he tell us that among the males not one of the cases occurred in the period of 1 to 5 years, and among the females none occurred under 1 year and only five under 5 years; whereas in a condition acknowledged by all to be of congenital origin, viz., inguinal hernia, in males more than a sixth and in females nearly a seventeenth occurred before the age of one year, according to statistics taken from the London Truss Society's Clinic. Surely, if the sac of a femoral hernia were a congenital one, we should expect that those children who became actually ruptured during the first fifteen years of life would be much commoner than one twenty-sixth of all cases. For the same period—viz., the first fifteen years of life—in cases of inguinal hernia the proportion is midway between one-third and one-fourth. Apparently in this connection the proportion would be higher if direct and therefore acquired inguinal herniæ had not been included in the statistics of the Clinic; I presume that they were so included in the absence of any statement by Macready to the contrary.

Further, Murray says¹¹ that in 200 consecutive post-mortem examinations, femoral diverticula were found in 47 bodies.

According to the theory which I shall later expound, this is not a very surprising thing quite apart from a congenital explanation. Also it would seem extraordinary, assuming Russell's theory to be correct, that in 23 per cent of cases what must be described as a developmental abnormality should have occurred. Keith, I believe, points out that no one has seen a diverticulum within the femoral canal at birth. Murray does indeed mention that in Ashby and Wright's *Diseases of Children* it is stated that Sabourin recorded a case of femoral hernia in a premature infant.

Finally Murray says¹² that "if the sac of a femoral hernia is formed originally in this way" (viz., "by some force pulling, rather than pushing, the peritoneum outwards"), "then some atrophied gubernacular fibres should be found at the fundus of the sac". He writes, "a few weeks after I had written the above remarks I secured in the post-mortem room the sac of a femoral hernia from the body of a man 61 years of age". This he sent to

the Clinical Research Association in London for microscopical examination. He received the following report: "Sections made longitudinally of the fundus of this hernial sac certainly show small bundles of striated muscle". Murray does, however, confess in a footnote that "recently I sent two femoral hernial sacs to the Clinical Research Association for examination, but the presence of muscle fibre at the fundus of the sac could not be demonstrated". Again he says, "I have not yet had the opportunity of searching for muscular fibres at the fundus of a femoral hernia sac in a woman, but I feel confident of finding them there".

Embryologists in general definitely and dogmatically assert that the muscle fibres of the gubernaculum are non-striated. But quite apart from this question as to whether these fibres are striated or not, who would expect that in a sac alleged to be 61 years old fibres of muscle would still remain in a condition to be defined—a very delicate muscle at its best, and one which had not been called upon to contract for 61 years! Murray clears up the question of striation or non-striation of the gubernacular fibres to his own satisfaction by demonstrating striated muscle fibres from "behind and below the epididymis of an adult".¹² He briefly says, "it represents normal gubernacular fibres in the mesorchium". One wonders, however, if these are not more likely to be fibres of the cremaster muscle.

I have spent some space in questioning the correctness of Russell's theory as applied to the femoral sac, more especially because in perusing recently a paper by Panton,¹³ "Factors bearing upon the Etiology of Femoral Hernia", to which I shall have occasion to refer later, I note that he accepts Russell's theory of the formation of the femoral sac, and accepts it, I think, too readily. One point especially appears to throw doubt on the congenital saecular theory which has as its basis the excessive growth of the gubernaculum; that point is the fact that although femoral hernia is more common in the female, yet in the female the gubernaculum is a much less active structure, if physiological results are anything to go by.

3. The Author's Theory.—My theory will not take long to enunciate. It is very simple and easy to understand. It may be called the 'acquired saecular theory', in contradistinction to the 'saecular theory' of Hamilton Russell, in which the sac is regarded as congenital or embryonic.

Man has an acknowledged weakness in the abdominal parietes at the crural ring. On the abdominal side of the ring we have an accumulation of loose properitoneal fat, which on its deep aspect has a certain adhesiveness to the peritoneum, which in its turn is loose and easily stretched. On its superficial aspect this fat is in direct continuity with the fat which plugs the space known as the crural ring. I have formed the opinion that under the influence of intra-abdominal pressure the properitoneal fat is herniated under Poupart's ligament between the femoral vein and Gimbernat's ligament into the thigh, carrying with it a small peritoneal diverticulum. Having once passed the narrow neck, it is allowed to expand into the connective tissue of the thigh, which is less resistant than the tissues around the neck of the sac. This expansion after passing the neck prevents its easy return through the crural ring. Occasionally the hernia of the properitoneal fat fails to bring down a peritoneal diverticulum, and we then get the type which I have

mentioned as the protrusion of properitoneal fat not containing a sac. It would appear to me that this hernia of properitoneal fat usually occurs gradually as the result of everyday abdominal strains, and up to a certain point may gradually increase in size simply in virtue of fresh abdominal fat being forced down. Surgeons will no doubt have noticed how, when one of these fatty sacs is exposed, a pull on it will bring down more fat from the deep side of the crural ring.

This gradual development seems to explain how it is that the small fatty sac may remain undiscovered until it acquires contents. On the other hand, more rarely it may occur suddenly, as in the case mentioned above, where there was a sudden strangulation of properitoneal fat containing a peritoneal sac. The fatty sac lies in the tissues of the thigh as an inconspicuous flat swelling, smooth and soft, but quite typical, and easily recognized by palpation. As a rule it causes no pain or discomfort, and even the subject may be unaware of its presence until it acquires some contents.

The sac within the properitoneal fat is often small and not easily found by the uninitiated when for the first time he is called upon to operate on such a case. In fact the novice will often jump to the conclusion that the thin fascia which demarcates this properitoneal fat from the fat of the thigh is the peritoneal sac itself.

The sac will remain of moderate size until at last some omentum finds its way in. Once in, the omentum, I maintain, can never get out again, being a passive structure held in the tight grip of the neck. More and more omentum comes down into the sac, so that the neck and the sac become more and more distended. As the sac becomes distended its fatty covering becomes more and more thinned, until in a well-developed hernia the peritoneum may have only a very thin layer of fat covering it. Quite a different picture is then presented from that of the small empty fat-laden sac of the early stage.

It is interesting to note that hernia of properitoneal fat is accepted by many as the cause of the fatty ventral herniæ found on one or other side of the linea alba, usually above the umbilicus. To quote from Thomson and Miles' *Manual of Surgery*¹⁴ in this connection: "A lobule of fat may be protruded through one of the spaces of the network. . . . As the plug of fat is further protruded it drags behind it a funnel-shaped process of peritoneum, which ultimately becomes the sac of a hernia". How much more likely is this to occur at the very dependent site of acknowledged abdominal weakness, the crural ring. It must, however, be admitted that Murray states¹⁵ that these herniæ in the linea alba are of congenital origin, though not, of course, due to errant gubernacula.

Relative Frequency of Femoral Hernia in Males and Females.—If the active cause of both the original protrusion of the properitoneal fat with its peritoneal sac through the crural ring, and the passage of viscera later into the sac, is intra-abdominal pressure, it is evident that any condition which chronically increases the intra-abdominal pressure renders a person of any age or sex more likely to develop a hernia of properitoneal fat, or to acquire by the protrusion of viscera an actual in place of a potential hernia.

I think we may take it for granted that the shorter Gimbernat's ligament is, the broader will be the space between its free edge and the femoral vein, and therefore the more likely is the individual to develop a femoral hernia, potential or actual. But in view of Panton's work we must be careful not to make use of the size of Gimbernat's ligament in order to find a reason why the female is more liable to the development of a femoral hernia than the male. In relation to the relative sizes of Gimbernat's ligament in the two sexes, he says,¹⁶ "the female average exceeds the male on the right side by 1 mm. only, and the left side measurements are in perfect agreement". He concludes, therefore, "that the sexual differences in the length of Gimbernat's ligament are negligible". Another point which he brings out is¹⁷ that the "female false pelvis is either relatively narrower than the male, or else equal to it; it certainly is not greater". He also says, "the female Poupart's ligament is relatively shorter than the male". His actual figures are: modern male average (Poupart), 12 cm.; female, 11.8 cm. As the greater frequency of femoral hernia in the female has in the past been accounted for practically universally on the grounds that the female false pelvis is wider than the male, we must, in view of the results of Panton's painstaking research, readjust our ideas on the subject.

I have been studying some statistics prepared by Macready from the Clinic of the City of London Truss Society during the years 1888, 1889, and 1890, contained in his inspiring work¹⁸ *A Treatise on Ruptures*. He calculates that between the ages of 21 and 65, the ages signifying when the rupture first appeared, the proportion of parous to non-parous women is as 3 to 1. Between these two ages we find in his complete tables 1087 women and 396 men suffering from femoral hernia. If to the female cases we apply the 3 to 1 proportion, we obtain roughly 778 parous women and 259 non-parous women. Therefore during the above three years we find the males have a majority of 137 over non-parous women. Of course we have to take another point into consideration—viz., how many of the parous women would have become ruptured even if they had not borne children. It is not easy to see how we can obtain this figure, but let us suppose it to be 20 per cent. This would mean that of the 778 parous women, 155 would have become the subjects of femoral hernia even if they had not had any children. Adding the 259 cases in non-parous women, we arrive at a total of 414, a majority of 18 over the men.

This juggling with figures may not be worth much, but I think that, coupled with Panton's findings, it is strongly suggestive of the idea that men are almost as liable to femoral hernia as women before they have had children, and therefore, that child-bearing is the one great factor which renders the female sex more liable to femoral hernia than the male. This is not surprising when one considers that for ten lunar months the intra-abdominal pressure is gradually increasing in a pregnant woman, and that this period is terminated by a still greater and more violent increase of pressure in the final act of expelling the child. It is true that for some part of the ten months the omentum and gut is kept away from the crural ring by the enlarged uterus; but what better conditions could be looked for than these for the pushing of properitoneal fat with the small peritoneal sac through the crural ring into

the thigh? One point, however, as far as I know, remains unexplained by any theory, and that is that among the comparatively few cases of femoral herniæ which occur before the age of puberty, about two-thirds occur in the female sex.

In 1911 I devised a method of treating the sac in the radical cure of femoral hernia, in which the sac was invaginated through the abdominal cavity and out through the anterior abdominal parietes well above Poupart's ligament. Here the sac was ligatured, cut off, and fixed. By this means the peritoneum and the properitoneal fat were drawn well up and away from the abdominal aspect of the crural ring. Having satisfied myself of the efficacy of this method by a three years' trial, I published it in 1914.¹⁹ With a few slight modifications in technique, and with the assistance of a special invagination forceps made for me by Thackray, of Leeds, I still use this method entirely in cases of both simple and strangulated femoral herniæ. I devised this method when I was beginning to realize the possible bearing of the properitoneal fat in the region of the crural ring on the development of the femoral hernial sac, and also the influence which this fat might have in producing a recurrence of the condition.

CONCLUSIONS.

1. That the sac of a femoral hernia is a pre-formed sac, and is not formed contemporaneously with the expulsion of a viscus.
2. That there is no sufficient proof that this pre-formed sac is of congenital or embryonic origin.
3. That the sac is acquired as a result of properitoneal fat being herniated into the thigh through that naturally weak site in man, the crural ring, and that this hernia of properitoneal fat drags with it a small peritoneal sac.
4. That anatomically a man is as much liable to a femoral hernia as a woman, and that the greater frequency of the condition in women is due to pregnancy and to the prolonged period of raised intra-abdominal pressure which that condition produces.
5. That no existing theory as to the etiology of femoral hernia accounts for the fact that among the comparatively few cases which occur below the age of 15 years, females have a two to one majority; but that this fact serves to throw doubt on the embryonic theory, in that normal physiological results suggest that the gubernaculum is a more active structure in the male than in the female.

Since writing this paper, I have been interested to see Mr. Russell's²⁰ short article in the *BRITISH JOURNAL OF SURGERY*. "Femoral Hernia, and the Saccular Theory". When he says, "During these years (1906 to 1923) I believe I may safely say that the saccular theory 'prevailed' and became firmly established among surgeons and surgical writers". I must confess that I am surprised and I think he is too optimistic in making the statement.

I note that he makes a strong point in reference to the direction taken "by a femoral hernia of any size after its emergence from the saphenous

opening", and he objects to the explanation often offered that the hernia follows the path of least resistance. He says, "the explanation becomes at once simple and obvious as soon as we recognize that the sac is a congenital structure". I fail to follow his reasoning, because it would seem to be obvious that in looking for the direction of the forces acting in bringing down the sac in the first instance, we must study the sac before it has changed its primary direction, as it does change it when it reaches the area of weakness in the deep fascia known as the saphenous opening. Now in my experience the direction taken by the sac before it has reached the saphenous opening is always downwards alongside the femoral vein, and therefore it would seem that without doubt the primary producing force, whether acting from above or below, must have been downwards. If the force had been produced, as Murray says, by the crural attachment of the gubernaculum, then one would have expected that the direction of the young sac would have been upwards and slightly inwards, namely, towards the point of exit of that strand of gubernaculum from the inguinal canal.

In reference to Panton's paper, Russell says that Panton has "clearly demonstrated the congenital origin of the femoral sac". I have read Panton's paper carefully, and I think that the above statement by Russell is too strong. What Panton has done is to make us readjust our ideas regarding the cause of the greater frequency of femoral hernia in women than in men, and realize that that cause is not a wider false pelvis, a longer Poupart's ligament, or a shorter Gimbernat's ligament. Regarding the question of whether there is a congenital factor in the etiology, he seems merely to review the existing evidence, especially as put forward by Murray, and to base his opinion on that without producing any additional evidence in support of the congenital theory. He certainly accepts the congenital theory, but, as I have said, I think that he does so too readily.

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THORACOSCOPY IN SURGERY OF THE CHEST.

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FOLLOWING the first use of the thoracoscope by Jacobæus some twelve years ago, thoracoscopy has become increasingly practised in the different European countries, and more especially in Scandinavia. It was primarily used as a method of diagnosis of the causative factors giving rise to exudative pleurisy, and only later developed into a means of treatment of pleural adhesions preventing pulmonary collapse in the treatment of pulmonary tuberculosis by artificial pneumothorax. This method of diagnosis and treatment has not, as yet, obtained much prominence in this country, and it is with a view to increasing its employment that this preliminary report is published.

The Thoracoscope.—Before proceeding to discuss the technique, it is advisable to give a brief description of the instrument.

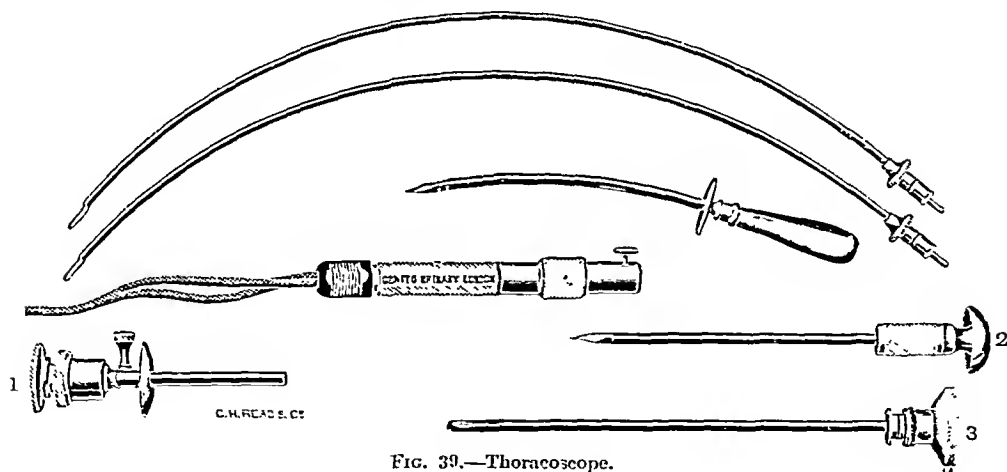


FIG. 39.—Thoracoscope.

The thoracoscope (*Fig. 39*) consists of a valved cannula (1), on the distal portion of which can be seen a shield, which, by adjustment of a small screw, can be varied in position; (2) is a simple trocar and cannula, the latter being to protect the point of the trocar in its passage through the valved cannula; (3) represents the telescope and terminal light, which also fits accurately the valved cannula. The remaining figures consist of the further instruments necessary for the cauterization of adhesions, and include two electric cauteries, the trocar and cannula for their introduction, and the connection and switch.

Technique.—

Preliminary.—The operation of thoracoscopy depends for its performance upon the presence of a space between the parietal and visceral pleuræ, and



FIG. 40.—Normal lung (near view).



FIG. 41.—Normal pleura (near view).



FIG. 42.—Outer edge of lung, with inner surfaces of ribs and intercostal spaces in lower left segment.



FIG. 43.—Lower edge of lung, showing diaphragm to right and parietes below.

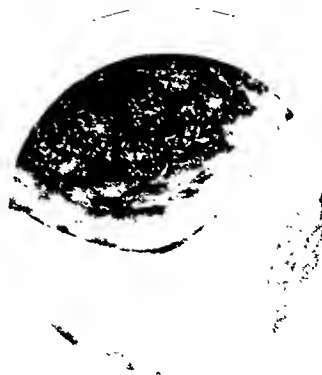


FIG. 44.—Outer inferior angle of lung above, diaphragm to right, and parietes below to left.

therefore, in those cases in which artificial pneumothorax has not already been induced as a method of treatment, its induction forms a necessary preliminary.

Where an effusion is present, the fluid is drawn off and replaced by gas.

The artificial pneumothorax can be induced by the introduction of oxygen, nitrogen, or air. The most common, from the point of view of treatment, is the introduction of air, previously filtered, but in cases where the induction is carried out solely for diagnosis or investigation it is advisable to use oxygen. In my opinion, there are two reasons for this: first, that, should it be necessary subsequently to perform thoracotomy, less difficulty will be found in obtaining rapid expansion of the lung, owing to the increased rate of absorption of oxygen in the meantime; secondly, the risk of gas embolism, at the first induction, is eliminated. Several inductions of gas will generally be required before the pleural separation is enough to give a comprehensive view.

Following the pneumothorax, skiagrams of the chest should be taken, preferably stereoscopic, in order to disclose any large areas of pulmonary adhesions and to indicate the most favourable site for the operation.

Operation.—This is preceded by an injection of omnopon, or of morphia, atropine, and hyoscine, and the skin of the chest wall prepared as for any surgical procedure.

The position of the patient upon the operating table is of some practical importance, as the facility of the operation is thereby increased. The patient is placed on his side, that side to be examined being uppermost, and a sandbag is arranged high under the lower axilla, and a pillow under the head. In this way the convexity of the spine towards the affected side is increased and the intercostal spaces are thereby widened.

The site of introduction of the thoracoscope will vary according to circumstances, but will necessarily depend upon two factors: (1) That it is necessary to introduce the instrument as near as possible to the area to be examined; and (2) That it is essential to be quite sure that it is not introduced into adherent lung. Both these points can be controlled by careful examination of the preliminary skiagrams. In general, the line just internal to the vertebral border of the scapula, after its rotation outwards by elevation of the arm, will be found suitable.

Having selected the site, the skin, subcutaneous tissues, and deep structures are freely infiltrated with novocain and adrenalin ($\frac{1}{2}$ to 1 per cent). It is important, if the operation is to be carried out painlessly, that great care be taken to infiltrate down to and include the parietal pleura. The latter can be ensured in every case by steadily infiltrating as the needle is being thrust inwards until, on withdrawing the piston, gas comes freely into the barrel.

A small incision large enough to admit the trocar is made in the skin with a tenotome, the shield on the cannula is adjusted to the thickness of the chest wall, and the trocar and double cannula are thrust steadily through the intercostal space, into the pleural cavity. The trocar is then withdrawn and replaced by the telescope, and the cavity illuminated. The cannula is held with the shield firmly pressed against the chest wall and the telescope now moves freely inwards and outwards. By movement of the instrument



FIG. 45.—View of normal appearance of inner surface of chest wall, ribs, and intercostal spaces.

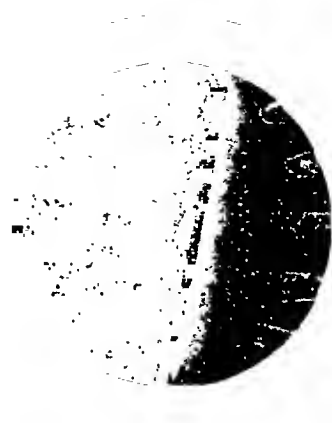


FIG. 46.—Distant view of outer edge of lung and chest wall.



FIG. 47.—Similar view to that in *Fig. 46*, but somewhat closer.



FIG. 48.—Site of needle punctures from gas refills: they appear as small vesicles.



FIG. 49.—Fibrous scar on surface of parietal pleura (? site of previous adhesion).

as a whole, lateral movement is obtained in addition, and by a combination of these movements the entire pleural cavity can be examined.

The Normal Pleural Cavity.—In the first place, it is important to remember that in all endoscopic vision the area under observation depends for its appearance on the distance of the prism of the telescope from the object and on the brightness of the illumination. Bearing this point in mind, it will naturally follow that the variation in appearances of structures in the large pleural cavity will be considerable—much greater than those of smaller cavities such as the bladder.

Fig. 40 shows the characteristic appearances of the normal lung when a 'close-up' view is obtained. It will be seen to be of a pale-salmon colour, with irregular areas of dark pigmentation, varying from grey to black, scattered irregularly. Small vessels can be seen in or below the visceral pleura, and the whole surface glistens owing to the thin film of moisture covering it. As a whole the appearance closely resembles a highly-polished marble. Various portions of the lung can be recognized, and *Figs. 42, 43,* and *44* show the outer edge, lower edge, and lower outer angle respectively.

On turning the telescope towards the parietes a close view of the pleura will appear, as in *Fig. 41*, where the surface is of a much brighter pink colour and distinct blood-vessels can be seen. The white patches represent the reflection of the lamp from the moist surface. A more distant view can be seen in *Figs. 45, 46,* and *47*, where the inner surfaces of the ribs and intercostal spaces can be clearly defined.

Turning downwards, the view is as represented in *Figs. 43* and *44*, where the darkened area of the left lower portion represents the parietes somewhat poorly illuminated, with the diaphragm bulging up in the lower right portion. The division between these two structures is the phrenico-costal sinus, in which it is not uncommon to find a small quantity of fluid.

Owing to the crowding of the lung about the hilum by the gas displacement, it is not possible to see structures in this situation unless they project considerably beyond the normal lung.

Pathological Conditions in the Pleural Cavity.—The most common pathological conditions arising in the pleural cavity occur as a result of tuberculosis.

The first is due to actual involvement of the pleura itself by the disease. I have not had this condition drawn, but it is quite a typical picture. Both layers of the pleura are considerably congested; the areas of pigmentation are hidden by a fine layer of granulation tissue, scattered through which small typical greyish nodules can be seen.

The second variety consists in the formation of adhesions between the two layers of pleura, not uncommonly overlying the site of a tuberculous cavity in the lung. These adhesions can be divided for practical purposes into three main groups: (1) Large flat surface adhesions extending over a comparatively large area of lung surface and appearing through the endoscope as a fusion of the two layers. These are most common at the apex. (2) Thin film-like adhesions, which are comparatively narrow when viewed from one aspect, but much broader from the other. This type can be seen oscillating during the examination, often synchronous with the heart-beat. They are well illustrated by *Figs. 50* and *51*, showing the same band from two directions



FIG. 50.—Membrano-like adhesion stretching across field; attachments out of line of vision.



FIG. 51.—Same band as in *Fig. 50*, but from another view at right angles to the former.



FIG. 52.—Complete view of short band towards apex, with edge of another band at lower left corner.



FIG. 53.—Firm band-like adhesions, showing pulmonary and pleural attachments.

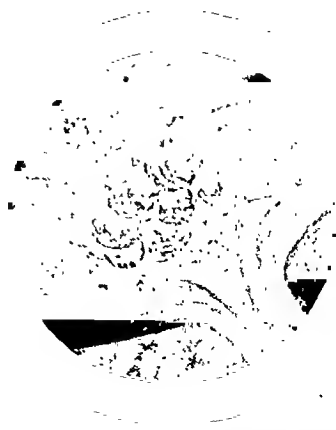


FIG. 54.—Pulmonary end of strap-like adhesion, with small mass of granulation tissue on lung above attachment, and parietes in distance.

at right angles to one another. (3) Longer or shorter strap-like adhesions, firm, pale, and fibrous-looking. These are almost invariably spread out at each end, with a slighter narrower waist towards the middle. They appear, and are, much more firm than the former variety, and show little or no movement. They are well represented in *Figs. 52, 53, 54*, and in the last is a small quantity of granulation tissue, probably representing the site of rupture of another adjacent band by the introduction of gas. *Figs. 48 and 49* are of some interest, the former representing the site of needle punctures which had been made to produce the artificial pneumothorax, the point of entry being now small cysts; and the latter a small area of scar tissue on the parietal pleura, possibly the site of a previously ruptured adhesion.

Indications and Contra-indications.—The method is indicated for diagnosis in all cases in which there is any real doubt as to the condition present in the pleura; for tumours growing from the pleura itself or projecting into the pleural cavity; and for the division of adhesions preventing collapse of the lung during the treatment of tuberculosis by artificial pneumothorax. This treatment is not considered in this communication.

The contra-indications consist of inability to induce a fairly considerable pneumothorax, and the presence of acute septic infection of the pleura. If performed for tuberculous empyema, great care must be taken, and the instrument should be introduced into the upper part of the pneumothorax cavity in order to prevent the subsequent formation of a fistula.

Complications.—The only complication, if such it may be called, that I have encountered, is the occurrence of a slight degree of surgical emphysema around the site of entry. The formation of a small quantity of fluid is quite common after induction of pneumothorax alone, and the frequency does not appear to be increased after thoracoscopy unless actual division of bands by the cautery is undertaken.

In conclusion, I should like to thank my medical colleagues at the Brompton Hospital for the opportunity of carrying out these investigations, and to express my indebtedness to Dr. P. L. T. Bennett, late Assistant Resident Officer, for his very excellent reproduction of the majority of the coloured drawings shown.

TWO RARE BONE DISEASES: HEREDITARY DEFORMING CHONDRODYSPLASIA AND CHONDRODYSTROPHIA FŒTALIS.

By J. RENFREW WHITE, DUNEDIN, NEW ZEALAND.

THE three cases recorded and illustrated in this note have come under the writer's care within the last year. They have been considered worthy of record, partly because of the comparative rarity of the two diseases of which they are typical examples, but also because of the remarkable similarity of the clinical appearances presented in *Cases 1 and 3* by two diseases of bone growth the essential natures of which have been regarded as almost diametrically opposite.



FIG. 55.—*Case 1.* Deforming chondrodysplasia. Note the symmetrical outgrowths from the metaphysal parts of the humerus, and the lower ends of the radius and ulna; the deformity of the forearms, and the outgrowths from the ribs.

Case 1.—A case of deforming chondrodysplasia (multiple cartilaginous exostoses or diaphysial aplasia).

G. M., age 26, a farm labourer, was admitted to hospital on May 13, 1923, complaining of: (1) Multiple swellings in the neighbourhood of the joints of the limbs that have been present since childhood; (2) Limitation of the range of movement at the shoulders and in the forearms, noticed for the last few years; (3) Pain on movement of the shoulders, of a few weeks' duration.

§ HISTORY.—The swellings were first noticed when the patient was a child, but exactly at what age he cannot now say; they have been growing slowly ever since.



FIG. 56.—Case 1. Deforming chondrodysplasia. Note the enlargements of the lower end of the ulna in each forearm



FIG. 57.—Case 1. Deforming chondrodysplasia. Symmetrical cartilaginous outgrowths from tibiae and femora; valgus position of feet from relative shortness of fibulae.



FIG. 58.—Case 1. Skiagram showing the 'exostosis' from the humerus, the swellings on the ribs, and the irregularities on the vertebral border of the scapula.

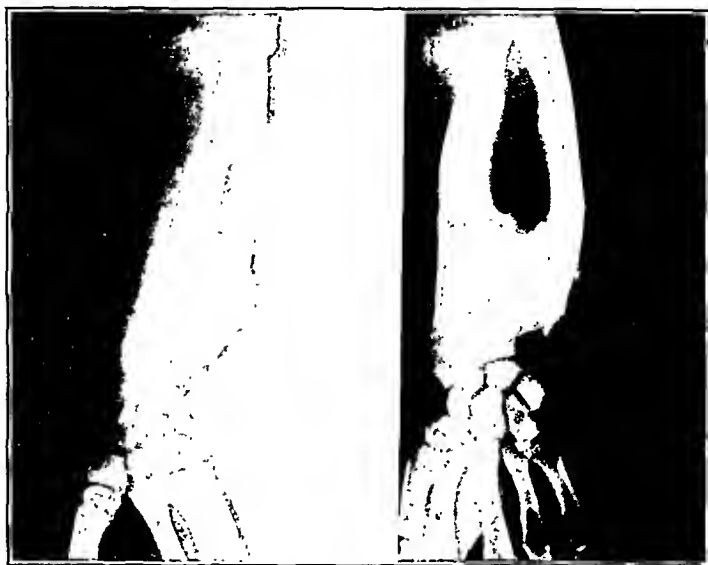


FIG. 59.—*Case 1.* Showing the extraordinary outgrowths from the lower end of the ulna, actually invading the radius; the relative shortness of the ulna, with increased obliquity of the wrist-joint; the freedom from similar disturbances in the metacarpus.



FIG. 60.—*Case 1.* This shows well an 'exostosis' growing from the upper end of the femur, and the extraordinary mass of irregular outgrowth from the crest of the ilium from the anterior to the posterior iliac spine.

When 18 years of age, the swellings around the right knee and hip began to cause pain on walking, so that on Jan. 30, 1917, he was admitted to hospital, and the tumours were removed from these regions. During the last few weeks he has been getting similar pain on movement of the shoulders. Previous history was negative, and no other cases have been known in the family.

EXAMINATION.—The patient is quite healthy looking, but is a partial dwarf, height only 4 ft. 6 in. There are present hard irregular bony masses of various shapes and sizes projecting from the following parts of the skeleton: (1) From the postero-internal aspect of the upper end of each humerus is a lump the size of a cricket ball (*Figs. 55 and 58*). (2) At the lower end of each ulna, growing backwards and outwards towards the radius is a rounded mass producing mechanically great limitation of radio-ulnar movement (*Figs. 56 and 59*). (3) Fusiform swellings on the fifth, sixth, and seventh ribs in the mammary line (*Fig. 55*). (4) From the vertebral borders of the scapulae, which are concave instead of convex inwards. (5) From the crests of the ilia are projecting large irregular masses (*Fig. 60*). (6) There are sears at the hip-, knee-, and ankle-joints of the left leg: whilst in the corresponding parts of the other leg the exostoses are still present (*Figs. 57 and 60*). *Fig. 57* shows well the flat-foot resulting from permanent eversion of the ankle-joints due to the disproportionate lengths of tibia and fibula.

OPERATION.—On May 23, 1923, the large single mass projecting from the upper portion of each humerus was removed. These were slightly pedunculated; their summits were covered with bursae, and they were capped with a layer of cartilage; the rest of the masses were formed of soft cancellous bone. The pathologist reported them as 'ossifying chondromata'.

The most striking clinical characteristics of this case were:—

a. The symmetrical distribution of the outgrowths from the metaphyses of the long bones of the limbs that develop in cartilage.

b. The diminution of normal growth in length of the bones affected by the bony outgrowths; this has resulted in a stunting of the patient's growth in height, the condition of partial dwarfism.

c. This defect of growth in length, however, has not affected the long bones of each limb segment equally; both in the forearm and in the leg one of the two companion bones is shorter than the other. In the forearm the ulna is relatively diminished in length as compared with the radius, and ends in a curious 'arrow-head' lower extremity. It is noteworthy that, in addition, it is the ulna from which the bony outgrowths are chiefly growing (*Fig. 59*). In the leg the fibula is relatively shorter than the tibia, so that the plane of the ankle-joint is oblique and the foot is thrown into a valgus position.

Case 2.—A case of deforming chondrodysplasia in a boy of 7 years.

This is a case of 'multiple exostoses' in a schoolboy of 7 years. Here also there was no family history of similar cases. For a year or two his mother had noticed difficulty in fitting him with boots, on account of lumps forming on the outer sides of his ankles; but apart from this, he had suffered no disability. He came under the writer's observation owing to the detection of his disease by the school medical officer during a routine examination.

This case differs from the first in the involvement of metacarpals and phalanges in the same process of abnormal bone development (*Fig. 63*). In all other respects the only difference between the two cases is one of degree.

These cases, then, are well-marked examples of 'deforming chondrodysplasia'. Instances of this disease have apparently been noted for centuries, but it is only comparatively recently that attention has been specially directed

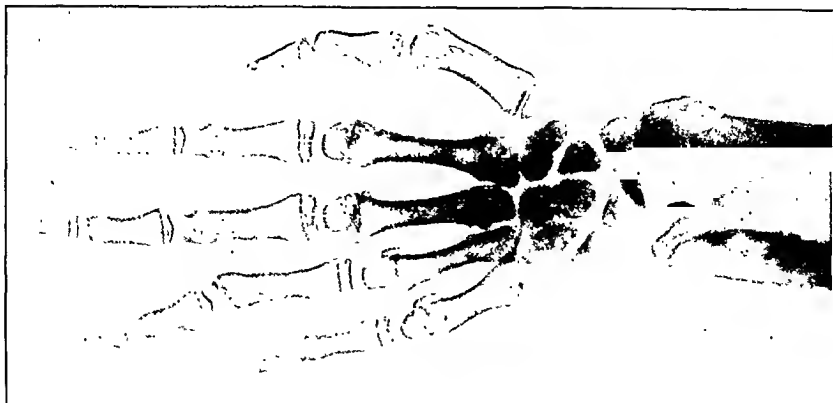


FIG. 63.—Case 2. Deforming chondrodysplasia affecting the metatarsals and phalanges as well as the lower ends of the radius and ulna.



FIG. 62.—Case 2. 'Multiple exostoses' around knee-joint. Note the deformation of the head of the fibula.



FIG. 61.—Case 2. 'Multiple exostoses' around the knee-joint: lateral view.

to it as essentially a specific disorder of bone-growth, the exostoses being merely the most obvious clinical sign of a peculiar disorder of endochondral ossification.

As far back as 1853 Sir James Paget wrote: "The last form of bony growths that I shall mention comprises the instances in which numerous exostoses occur in the same patient. Of these last we may specially observe that the tendency to osseous overgrowth is often hereditary, and that its result is a symmetrical deformity. Many similar cases of symmetrical and hereditary osseous outgrowths might, I believe, be adduced; and all their history suggests that they are to be regarded clearly as related not less closely to malformations or monstrosities by excessive development than to the osseous tumours of which I have been speaking. Indeed, at this point the pathology of tumours concurs with that of congenital excesses of development and growth."

In 1915, in the *Journal of the American Medical Association*, Ehrenfried gave a summarized account of 600 cases collected from 300 individual communications. He established it as a specific clinical and pathological entity, different from a condition of multiple tumour-formation. He showed the frequency of its hereditary and familial occurrence, and gave it the name 'hereditary deforming chondrodysplasia'.

The skiagrams of this present case would certainly seem to prove that the condition is essentially one of irregular overgrowth in width of the diaphysial cartilages, possibly due, as Sir Arthur Keith suggests, to failure of the limiting action of the subperiosteal formation of bone.

Case 3.—Chondrodystrophia fœtalis (achondroplasia).

This patient, a boy of 11 years, was admitted to hospital because of progressive difficulty in walking owing to the bowing of the bones of his legs.

He appeared quite normal at birth, but he was late in walking. When he was four or five years old his legs began to bend. Three years ago his growth, which hitherto had been very slow, seemed to stop altogether as regards his limbs. When stripped and examined he presented a typical picture of achondroplasia (*Fig. 64*). His arms and legs are very short in proportion to his trunk and head. The bilateral knock-knee, the bent legs and arms, the epiphysial swellings, the short fingers with trident hand, the deformation of the chest wall, and the lordosis are all typical. In addition, he had marked permanent limitation of extension of both elbow-joints, with very great ligamentous laxity of wrist- and knee-joints.



FIG. 64.—Case 3. Achondroplasia with deformities of the bones of the legs, necessitating the performance of osteotomies.



FIG. 65.—Case 3. Chondrodystrophia foetalis. Marked arrest of endochondral ossification about the knee. The patella is well formed.



FIG. 66.—Case 3. Chondrodystrophia foetalis, showing changes in the femora and innominate bones.

If *Figs. 55, 56 and 57*, and *Fig. 64* be compared, close similarity of appearances is to be made out. Both cases present short limbs—a condition of partial dwarfism; bony swellings about the epiphysial levels of the long bones of the limbs; bending of the bones of forearm and leg; deformity of the chest, with prominent nodes at the junction of rib and costal cartilage:



FIG. 67.—*Case 3. Chondrodystrophia foetalis*, showing the affection of the bones of the forearms and the bones of the hands, both metacarpal bones and phalanges.

and limitation of full extension at the elbow-joints. The similarity in clinical appearance is remarkable in view of the absolutely dissimilar nature of the defect in bone development as seen by comparing *Figs. 58, 59 and 60*, with *Figs. 65, 66 and 67*.

EXPOSURE OF THE HUMERUS AND FEMORAL SHAFT.

BY ARNOLD K. HENRY, DUBLIN.

THE following simple exposures of the humerus and femur seem to have escaped formal description, though doubtless the first has been used unconsciously by many. I have found them more satisfactory than the methods usually employed; they respect anatomy, give wide access, and save time.



FIG. 68.—Dissection of the right arm seen from the outer side. The uncovered outer fourth of the brachialis appears between the biceps and supinator longus, and extends behind the pointed deltoid insertion. It can be used as a buffer to protect the musculo-spiral nerve. The occasional small branch of the musculo-cutaneous to the brachialis muscle is shown.

A, Deltoid. B, Pectoralis major. C, Brachialis. D, Biceps. E, Cephalic vein. F, Occasional branch of musculo-cutaneous to brachialis. G, Supinator longus. H, Musculo-cutaneous nerve.

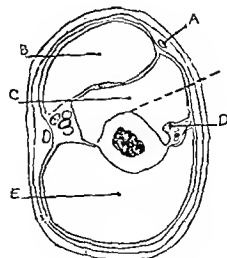
THE HUMERUS.

Exposures as a rule define structures to avoid, or else avoid them completely: the method in question is a compromise. It lays bare the front of the humerus from end to end, leaving the musculo-spiral nerve protected and concealed; if further exposure is required, the nerve is directly available.

Anatomy (Fig. 68).—The *cephalic vein* follows the outer border of the biceps and the inner border of the deltoid, piercing the deep fascia in the lower third of the arm. It receives two or more tributaries on its outer side: these must be divided. The humeral branch of the thoracic axis artery accompanies the vein in the groove between the deltoid and

FIG. 69.—Cross-section through mid third of arm, showing the outer fourth of the brachialis left uncovered by the biceps belly. This part of the brachialis is split in the direction of the broken pointer to expose the humerus. The musculo-spiral is safe.

A, Cephalic vein. B, Biceps. C, Brachialis. D, Musculo-spiral. E, Triceps.



the pectoralis major, and gives branches to both muscles. The inner three-fourths of the wide *brachialis muscle* are covered by the *biceps belly* (Paulet): the way to the humerus here is through the uncovered outer fourth (Fig. 69). The *deltoid*, arising in front from

the edge of the clavicle's lesser curve, forms a thick unyielding curtain which gives, when pulled aside, a grudging revelation of the shoulder-joint. This is often the last successful thing it does.

The *cutaneous branch of the musculocutaneous* curves forward at the outer edge of the biceps just where the belly joins the tendon of insertion. One of its filaments is cut in the upper third of the forearm. An inconstant filament from the musculocutaneous described by Luschka and Henle, but neglected by many more recent authorities, supplies the outer fourth of the brachialis muscle in its distal part. I have found it three times in ten arms. The other branches to the brachialis are under cover of the inner portion of the upper half of the biceps belly.

The *musculospiral nerve* (the radial of the B.N.A.) runs deep in the plane of cleavage between the brachialis and the supinator longus (brachio-radialis of the B.N.A.). It reaches the outer side of the humerus one finger-breadth below the pointed insertion of the deltoid, and then curves very slightly forwards and down. Part of the nerve which lies behind the humerus is usually separated from the shaft by the pointed inner head of the triceps. The distal half of this retro-humeral portion, measuring a little more than an inch, is the only part of the nerve in direct contact with bone.

The Operation.—

Position.—The patient lies with the limb close to his side and supported by the operating-table. The elbow is extended, and, when required, is flexed by an assistant.

Incision.—For exposure of the *shaft*, the skin incision (*Fig. 70*) follows the cephalic vein from the coracoid tip to the bend of the elbow, and is continued into the forearm in the mid-line of its upper third. The vein is exposed, and the outer edge of the biceps belly defined by dividing the deep fascia along its outer side.

Partial exposure of the bone may be obtained by shorter incisions, but these should never be short. Thus, to expose the distal part of the shaft, continue the incision well into the upper third of the forearm, dividing the deep fascia with blunt-nosed scissors to avoid injuring the radial artery and the cutaneous terminal (radial) branch of the musculospiral nerve: this division of the fascia allows wide retraction of the muscles.

Cut down on the humerus, first along the deltoid border; then divide the exposed outer fourth of the brachialis muscle longitudinally, a finger-breadth from the outer edge of the biceps. This cut is directed *inwards* to reach the humerus in the middle line (*Fig. 69*); it avoids Luschka's filament to the brachialis, and splits the muscle where its fibres are longitudinal. The



FIG. 70.—Cut through skin and deep fascia along the dotted line. (The arrow marks the 'step-down' at the acromioclavicular joint.) Expose (1) the deltoid attachment to the outer third of the clavicle, (2) the inner edge of the deltoid, and (3) the outer edge of the biceps. Continue the division of deep fascia throughout the upper third of the forearm. Split the brachialis as shown in *Fig. 69*.

outer strip of the brachialis, thus separated, forms a buffer which protects the musculospiral nerve from the rugine. The nerve is not seen if the front only of the humeral shaft is exposed, and the back too can be cleared safely while the nerve is concealed; but should the surgeon wish, the musculospiral can be found one finger-breadth distal to the deltoid insertion by further mobilizing the outer portion of the brachialis and retracting it outwards and back; the nerve then appears behind the upper fibres of the muscle, and the pull on the brachialis strip removes it just sufficiently from contact with the shaft to allow the rugine safe access to the bone. The nerve is most lax when the arm is adducted and the elbow flexed through 80° ; it is then most easily protected.

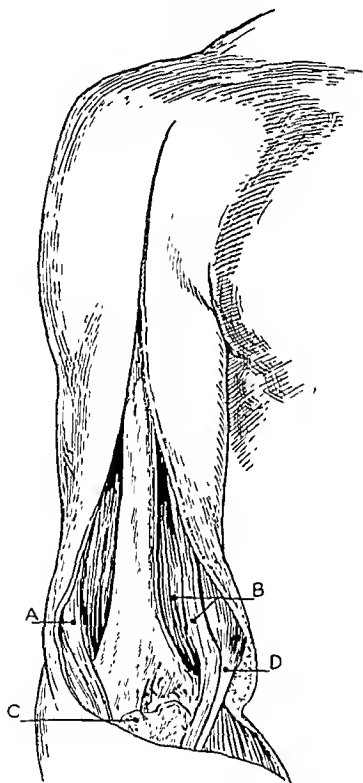


FIG. 71.—Separate the split brachialis from the bone; retract the inner and outer portions of the muscle. Relax it by flexing the elbow. The lower half of the bone is now exposed. In the figure the elbow-joint is opened and the coronoid process is seen. If exploration of the elbow-joint is not required, check the cut in the brachialis two finger-breadths above the epicondyles.

A, Brachialis (outer portion). B, Brachialis (inner portion). C, Coronoid process of ulna. D, Biceps tendon.

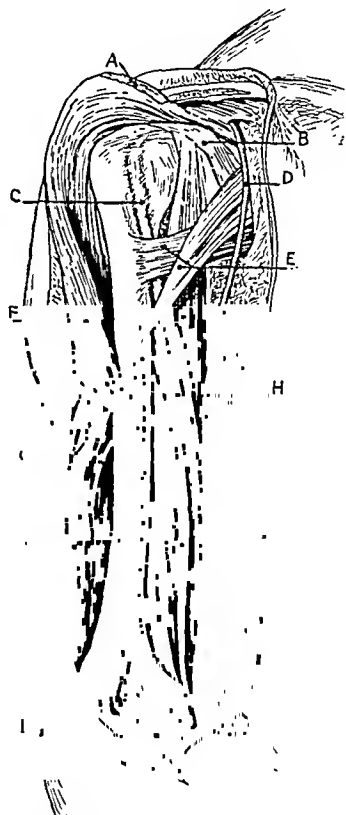


FIG. 72.—Complete the exposure of the humerus by turning the deltoid outwards on a hinged chip cut from the clavicle (see also Fig. 73). The musculospiral can be found, if required, by detaching the part of the brachialis which extends behind the deltoid tip.

A, Hinged chip of clavicle with deltoid origin. B, Coracoid process. C, Long head of biceps. D, Cephalic vein. E, Pectoralis major. F, Deltoid. G, Musculospiral. H, Biceps. J, Brachialis (outer portion). K, Brachialis (inner portion). L, Coronoid process.

The incision may be carried through the brachialis to within two finger-breadths of the level of the epicondyles, without entering the elbow-joint.

The bone seen through the split brachialis appears to lie at a considerable depth when the joint is extended. Flexion of the elbow to a right angle transforms this appearance, relaxing the muscle and leaving the bone widely accessible in a shallow wound (*Fig. 71*).

The front of the humeral shaft is now exposed in its entire length, completely in its lower half, but above, the deltoid yields insufficiently to retraction and gives a mere glimpse of the bone.

The Shoulder-joint.—This, with the upper part of the shaft and the tuberosities, can be exposed by continuing the skin incision outwards on the upper surface of the clavicle to the acromioclavicular joint, easily found by running the finger out along the clavicle; the finger takes, as it were, a step down at the joint (*Fig. 70*). Expose the deltoid origin by reflecting the skin. Divide the fascia and periosteum on the upper face of the outer third of the clavicle. With a chisel, detach the edge of bone which gives origin to the deltoid, as far as the acromioclavicular joint. The deltoid can then be turned outwards on a hinged piece of bone, like a sail on a spar (*Figs. 72, 73*).

When the shoulder-joint has been dealt with, sutures passed through the muscle and round the clavicle lash the spar back into place, and reconstitute the deltoid origin (*Fig. 73*).

The Elbow-joint.—This joint can be opened by extending the incision through the brachialis. The tip of the coronoid process and the trochlea are at once visible; the head of the radius and the capitulum appear with adequate retraction (*Fig. 71*).

When the operation on the bone is finished, extension of the elbow, before suturing the fascia, closes of itself the wide wound in the muscle.

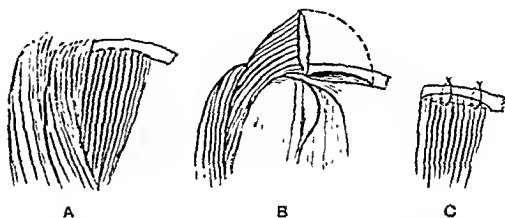


FIG. 73.—Cut the hinged chip from the clavicle along the line shown in A. B. Turn the deltoid out upon the hinged chip. C. Reconstitute the deltoid origin with two sutures which tie the chip back into place.

THE FEMORAL SHAFT.

Exposure of the femur from the outer side of the limb is popular because it does not enforce reflection; the surgeon cuts down on bone with a feeling that the femorals are safe. The inconvenient, unsightly, and bloody wound suggests, however, that security has been attained at a price, and with a certain disregard for structure. The incision transects the oblique fibres of the vastus externus, the goal of four perforating arteries, and of the large descending branch of the outer circumflex; and unless the patient is maintained in a lateral position, the surgeon works in discomfort. The method described here respects anatomy, is almost bloodless, and gives a wide and convenient exposure. Over twelve inches of the shaft, from the level of the small trochanter to the lower epiphysis, are freely available: the surgeon looks directly down on the front of the bone, and can see both sides of it in comfort.

Anatomy.—The strong fascia of the thigh is loosely attached to the thin sheaths of the rectus femoris and vastus externus. When it is divided the upper two-thirds of these muscles are easily separated by the finger, which finds the intervening plane of cleavage most easily a hand-breadth below the great trochanter (*Fig. 74*).

Near the patella the aponeurotic fibres of the vastus fusc with the rectus tendon, preventing further separation by the finger. When the rectus femoris and vastus are retracted, the silvery surface of the crureus (vastus intermedius of the B.N.A.) (*Fig. 75*) appears, and separation of its longitudinal fibres reveals the femoral shaft.

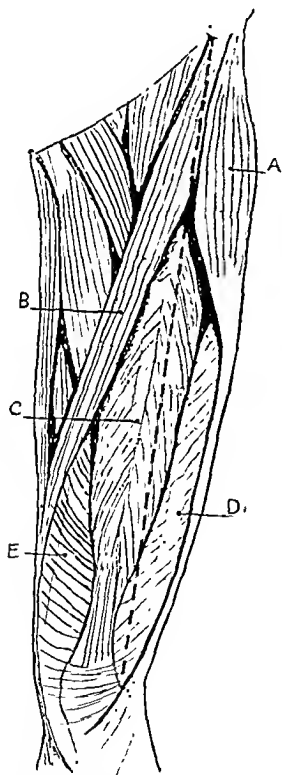


FIG. 74.—Cut through skin and fascia along the dotted line, from the anterior superior spine of the ilium to the outer angle of the patella. Find the plane of cleavage between the rectus femoris and vastus externus one hand-breadth below the great trochanter, where the rectus sinks into the angle between the sartorius and the tensor fasciæ.

A, Tensor fasciæ. B, Sartorius. C, Rectus femoris. D, Vastus externus. E, Vastus internus.

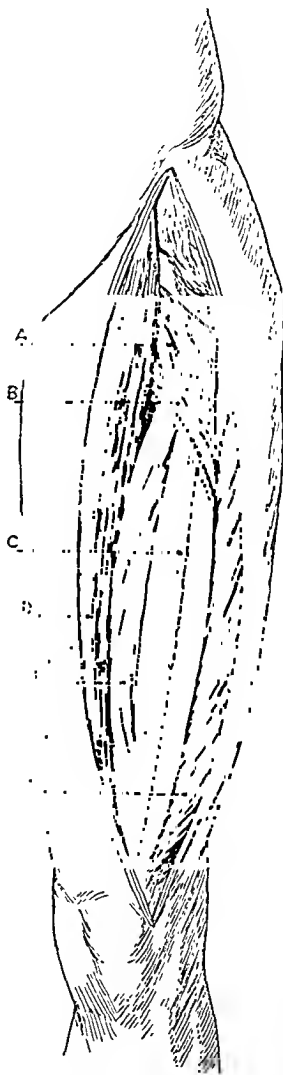


FIG. 75.—Separate the rectus femoris from the vastus externus, exposing the crureus, which is crossed obliquely by a neurovascular bundle (the descending branches of the external circumflex vessels and the nerve to the vastus externus). The artery shown above the nerve is the transverse circumflex branch lying in front of the neck of the femur.

A, Nerve to vastus externus. B, Descending branch of external circumflex artery (with veins). C, Crureus. D, Rectus femoris. E, Vastus internus. F, Vastus externus.

Two structures must be considered before the bone is exposed. The first is an oblique neurovascular bundle which consists of the descending branch of the external circumflex artery, its companion veins, and the nerve to the vastus externus. This bundle is found a hand-breadth below the trochanter. The second structure, the suprapatellar pouch, extends for the same distance above the pointed extremity of the patella. As each of these must be specially dealt with by the surgeon, they will be further described with the operation itself.

The Operation.—

Incision.—The skin and deep fascia are divided along a line from the anterior superior iliac spine to the outer angle of the patella (*Fig. 74*).

Planes of Cleavage.—The finger finds the interval between the rectus femoris and vastus externus, a hand-breadth below the great trochanter, and the muscles are separated by means of the finger, which may meet one or two vessels passing to the rectus; these are caught and divided. In the lower third of the thigh the finger is checked where the aponeurotic fibres of the vastus join the rectus tendon, and the knife must be used to separate them. The blade is kept parallel to the face of the quadriceps tendon, and a plane of cleavage will be found in this trilaminar structure, between the contribution from the rectus and that from the vastus, which permits their separation down to the patella. In septic conditions, however, the laminae of the quadriceps tendon should not be separated beyond a level one hand-breadth proximal to the apex of the patella. A small protrusion of the suprapatellar pouch sometimes pierces the tendinous contribution from the vastus externus below this level, and may be sliced open. The synovial cavity of the knee might thus be infected. When the two muscles are mobilized and drawn apart they expose the silvery surface of the crureus.

The Neurovascular Bundle.—The oblique descending branches of the

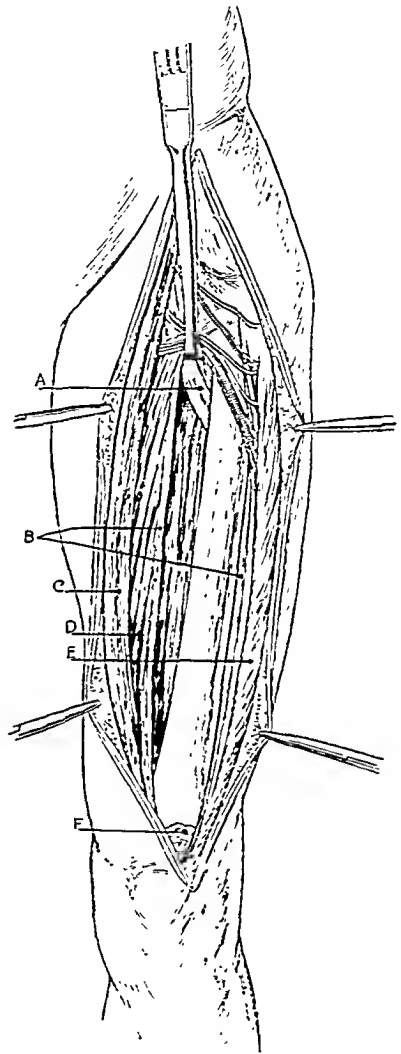


FIG. 76.—Mobilize and retract the neurovascular bundle. Split the crureus along the dotted line shown in *Fig. 75*. Avoid the suprapatellar pouch by checking the cut through the crureus one hand-breadth proximal to the pointed end of the patella.

A, Iliopsoas insertion. B, Crureus (split). C, Rectus femoris. D, Vastus internus. E, Vastus externus. F, Suprapatellar pouch.

external circumflex vessels and the nerve to the vastus externus are now seen passing across the crureus from beneath the rectus femoris to strike the free edge of the vastus externus, into which they sink. They run in a streak of fat, roofed by thin fascia, and are easily mobilized by drawing a knife along its lower edge; they are retracted proximally (*Fig. 76*). The surgeon can then cut to the bone through the upper portion of the crureus.

A large vein is often divided in this part of the muscle.

The Suprapatellar Pouch.—This, extending a hand-breadth above the apex of the patella, is easily avoided by checking the cut through the crureus above this level. The rugine works against the bone in a layer of fat, and separates the pouch from the femur.* If necessary, a retractor can be slipped between the pouch and the bone, and flexion of the thigh, relaxing the quadriceps, gives access to the lower end of the shaft.

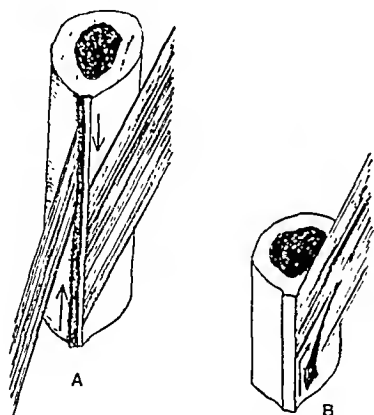


FIG. 77.—Work the rugine into the acute angle A which the muscular attachments make with the bone. B shows how the rugine tears into a muscle when used in the reverse direction against the obtuse angle.

When the two halves of the split crureus are separated from the bone and drawn apart, over a foot (32 cm.) of the femoral shaft is exposed—from the lower epiphysis to the lesser trochanter. At the inner side of the shaft the attachment of the muscles to the linea aspera is visible. If it is necessary to clear the linea aspera, the direction of the fibres should be noted; the edge of the rugine should travel into the acute angle which they make with the bone. If the rugine is used in the opposite direction, it tends to leave the bone and tear into the muscle (*Fig. 77 B*). The direction of the muscle fibres varies, of course, at the same part of the bone.

Thus the adductors travel down *to* the femur, while the vasti and short head of the biceps travel down *from* the femur. These attachments are cleanly separated by proceeding with method.

The surgeon should begin on the inner side of the linea aspera. The thin origin of the vastus internus which constitutes the internal intermuscular septum (Poirier) is easily seen, and is detached from the linea aspera by working the rugine up along the shaft. The adductor insertions which form the next layer are then separated by using the rugine in the reverse direction.

On the outer side of the shaft the rugine is worked up against the origins of the vastus externus and short head of the biceps. The strong external intermuscular septum should be dealt with last; its lowest fibres are irregularly arranged, but its attachment to the linea aspera can be exposed to view by

* Attempts at separating the pouch from the quadriceps tendon will as a rule tear the pouch. (The pouch, of course, communicates with the knee-joint.)

drawing the vastus externus towards the back of the thigh. If the surgeon then seats himself for a moment with his eyes level with the wound, the perforating vessels will be seen coming through the arched openings of the septum; and since the vessels are drawn backward in these roomy arches by retracting the muscles, they will not be injured when the septum is cut close to the bone.

Counter-openings for drainage may be made with perfect safety by cutting down on the tip of a forceps passed between the outer moiety of the crureus and the bone. The forceps follows the outer face of the external intermuscular septum, and since, in the recumbent posture, this septum is almost vertical to the bed, drainage is excellent.

In conclusion I wish to express my thanks to Professor E. J. Evatt, D.S.O., for the opportunity of working out these methods in the Royal College of Surgeons, Ireland, and to Mr. M. Barry, of the School of Art, Dublin, for his drawings of the operations.

A CAUSE FOR THE FREQUENT OCCURRENCE OF GANGRENE AFTER LIGATURE OF THE POPLITEAL ARTERY.

By JOHN S. B. STOPFORD, MANCHESTER.

THE frequency of the occurrence of gangrene after occlusion of the popliteal artery is well known, and only recently Sir George Makins¹ has stated that "injuries to the popliteal vessels enjoy a more evil reputation than those affecting any other artery of the limbs"; yet the reason for this is by no means clear. Many ingenious explanations have been advanced at various times, but a vague reference to the inefficiency of the collateral circulation is the reply most commonly received to any inquiry as to the cause for the very serious risk of gangrene after obstruction of the popliteal artery. This explanation appears to be inadequate, and particularly unsatisfactory when it is recalled that gangrene is much less frequent after ligature of the superficial femoral artery, although following this procedure the distal part of the limb must depend upon practically the same anastomoses. Makins records gangrene in 20·4 per cent after ligature of the superficial femoral, and in 45·8 per cent after injury to the popliteal.

An anatomical explanation for the very frequent incidence of gangrene consequent upon popliteal obstruction has for some time interested me, and an opportunity of studying a patient suffering from this condition, through the kindness of my colleague, Professor E. D. Telford, suggested that I should place it on record.

The patient was an electrician, age 50, who had never previously, to his knowledge, suffered a day's illness. He first came under Dr. P. R. Cooper's observation on account of the appearance of dry gangrene in the left foot and toes. There had been an absence of pain, and there was nothing to suggest a cause for the obvious arterial obstruction. The Wassermann test was negative, no evidence was discovered of cardiac or renal disease, and the blood-pressure was not raised.

After amputation through the lower third of the thigh, Professor Telford kindly permitted me to make a full examination of the limb. On opening the popliteal space an abnormal amount of fibrous tissue was encountered in the deeper part, and the vessels could not be cleared with the customary ease, which suggested some peri-arteritis. A complete obstruction of the popliteal artery, about three-quarters of an inch in length, was found at the level of origin of the inferior articular branches, and the orifice of each of these vessels was absolutely occluded. Microscopic sections through the obstructed part of the popliteal artery demonstrated the cause to be thrombosis; but histological examination of the popliteal above the level of the lesion, the superficial femoral, and the anterior tibial arteries, failed to reveal any reason for the formation of the clot.

It is difficult at first to understand the reason for the onset of gangrene consequent upon a localized, and probably gradually formed, obstruction of the popliteal artery in a patient with otherwise healthy vessels. Reference to the possible collateral circulation (*Fig. 78*) seems to suggest the only serviceable explanation. After occlusion of the popliteal artery, the blood passes from above to the patellar anastomoses through the descending branch of the external circumflex, the anastomotica magna, and more indirectly through

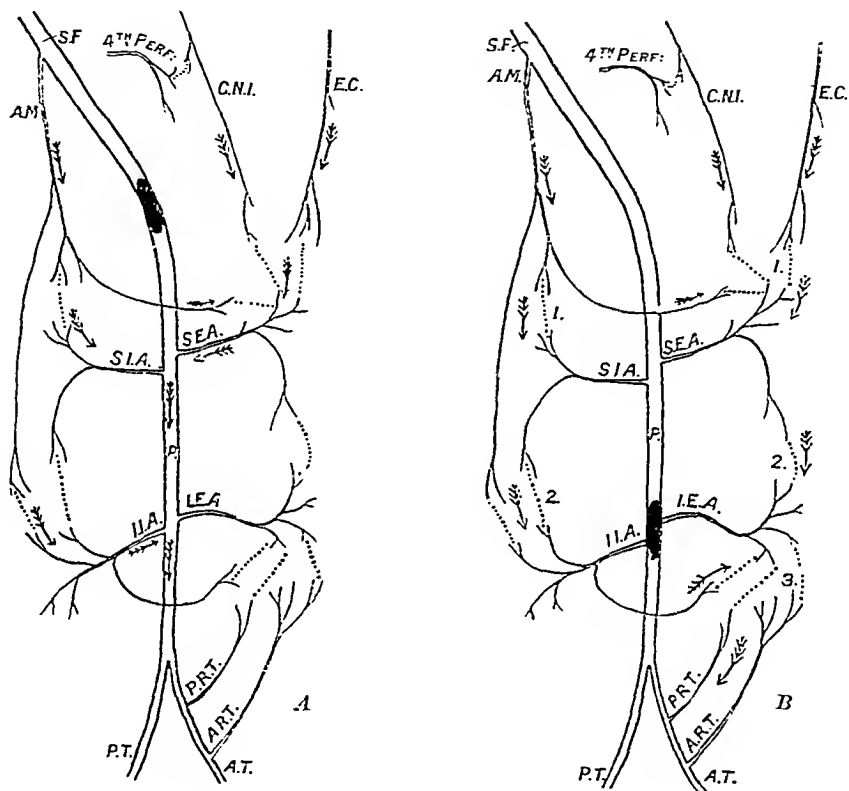


FIG. 78.—Diagrams to illustrate collateral circulation after obstruction of the popliteal artery (*A* in upper third, and *B* in lower third). S.F., Superficial femoral artery; P., Popliteal artery; P.T., Posterior tibial artery; A.T., Anterior tibial artery; E.C., Descending branch of external circumflex artery; A.R.T., P.R.T., Anterior and posterior recurrent tibial arteries; S.I.A., S.E.A., Superior internal and external articular branches; I.I.A., I.E.A., Inferior internal and external articular branches; A.M., Anastomotica magna artery; C.N.I., Comes nervi ischiadici branch of sciatic artery; 4th Perf., Fourth perforating artery. 1, 2, 3. The three sets of arterial communications which have to be 'opened up' when obstruction occurs in the lower part of the popliteal artery.

the comes nervi ischiadici branch of the sciatic and the perforating arteries. If the obstruction occurs distal to, or at the level of, the origin of the articular branches of the popliteal, the blood can only reach the leg and foot by traversing the two recurrent branches of the anterior tibial artery. Since the latter vessels only anastomose to any extent with the inferior articular branches, the blood coming from above, in order to reach the distal

part of the limb, has to open up the fine communications between (a) such vessels as the anastomotica magna and the superior articular branches; (b) the superior and inferior articular branches; (c) the inferior articular branches and the recurrent tibial arteries.

This means that to provide a collateral circulation, *three* anastomoses in succession must really be opened up, and in view of this it appears less surprising that injuries to the popliteal artery are so commonly succeeded by gangrene. In fact, when the small size of the normal recurrent tibial arteries is also recalled, and the frequent irregularity of the posterior one remembered, it seems more surprising that sufficient blood to maintain the life of the tissues ever reaches the foot after ligature of the lower part of the popliteal artery.

After ligature of the superficial femoral or popliteal above the level of the origin of the superior articular branches, only one set of anastomotic communications have to be opened up, since the blood can reach the popliteal through the main stems of the superior articular branches and pass by normal channels to the leg and foot.

The figures collected by Makins thoroughly support the view put forward in this paper, as he discovered that, in injuries to the popliteal artery, the situation of the wound considerably influenced the occurrence of gangrene. In 60 cases he found gangrene in 20 per cent when the injury affected the upper third (which is most probably above the origin of the superior articular branches), in 40 per cent in the middle third, and in 35 per cent in the lower third. These percentages show—as my explanation would lead us to conclude—that the occurrence of gangrene is only as frequent after obstruction of the upper third of the popliteal artery as after obstruction of the superficial femoral, but if the course from the articular branches through the popliteal to the anterior and posterior tibial arteries is impeded, the risk of gangrene is very markedly increased.

REFERENCE.

- ¹ MAKINS, G. H., *On Gunshot Injuries to the Blood-vessels*, John Wright & Sons Ltd., Bristol, 1919.

'MESENTERIC CYSTS': WITH A REPORT OF TWO CASES.

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THE first known case of a mesenteric cyst was described by Benevieni, the Florentine anatomist, in the 16th century. Since that time about 250 cases have been published, chiefly by surgeons. These cysts are found rarely, and their etiology is so uncertain that it seems worth while to record the following example which occurred recently in the hospital practice of one of us (T. T. H.). The opportunity has been taken to describe at the same time a second case which, though clinically very different, presents points of similarity to the first which we think suggest a close relation between the two, or at least constitute a useful parallel. We propose to describe these cases in detail, to give a short summary of current views on the etiology, symptomatology, and treatment of mesenteric cysts, and to discuss the relationship between the two cases and such views.

CASES.

Case 1.—C. O., a boy, 5 years old, was admitted to the Hospital for Sick Children, Great Ormond Street, on May 24, 1923, suffering from an undiagnosed abdominal swelling. The history given by his parents, who were well educated, was that the child was 'perfectly well' until three weeks before admission, when a swelling was accidentally discovered in the left side of the abdomen. This swelling was entirely symptomless, and they had noticed no change in the child beyond slight irritability and a tendency to tire easily. His appetite was normal, he was not getting thinner, and there was nothing to suggest implication of the alimentary or urinary tracts.

ON EXAMINATION.—The child was normal except for his abdomen, which was enlarged asymmetrically. A very large mass could be felt occupying the whole of the right side of the abdomen, passing across the mid-line into the left umbilical and lumbar regions. It was distinct from the liver and spleen, and its surface was smooth. It felt tense, but not definitely cystic, and was immobile. The swelling was painless on examination, and dull on percussion, except where intestine lay in front of it. X rays demonstrated a retroperitoneal tumour pushing the intestine forward, but nothing abnormal could be felt per rectum, and the blood and urine were normal. Dr. R. S. Frew reported that the heart and lungs were also normal. An exact diagnosis could not be made, but a sarcoma of the right kidney and an encysted tuberculous peritonitis were considered possible.

OPERATION.—Exploratory laparotomy was carried out (T. T. H.) on May 31, and the swelling exposed through a right rectus incision. During the operation 14 oz. of citrated blood were given intravenously. The swelling was found to be a very large unilocular cyst lying retroperitoneally behind the termination of the superior mesenteric artery; this artery and its accompanying vein were stretched across the cyst, which lay between the ascending colon on the right and the small intestine on the left (*see Fig. 79*). Complete removal was obviously impossible, so the cyst was tapped, and 35 oz. of turbid brown odourless fluid, shimmering with cholesterol crystals, were removed. Below the main cyst and in the ileocaecal angle of the mesentery were many thin-walled smaller cysts the size of a split pea and

containing a clearer fluid. These were probably simple dilated serous spaces in the mesentery caused by the pressure of the tumour. It was decided that marsupialization was the only feasible method of treatment. Accordingly the cyst wall was freely incised, the contents were completely evacuated, and the cavity was sponged out with gauze; finally the edges of the opening were accurately sutured to the lower half of the abdominal wound. A large drainage tube was inserted into the cavity of the cyst, and the upper half of the abdominal wound was closed in the usual way. At subsequent dressings the cavity was plugged with gauze soaked in flavine in liquid paraffin in the hope of inducing intra-cystic adhesions.

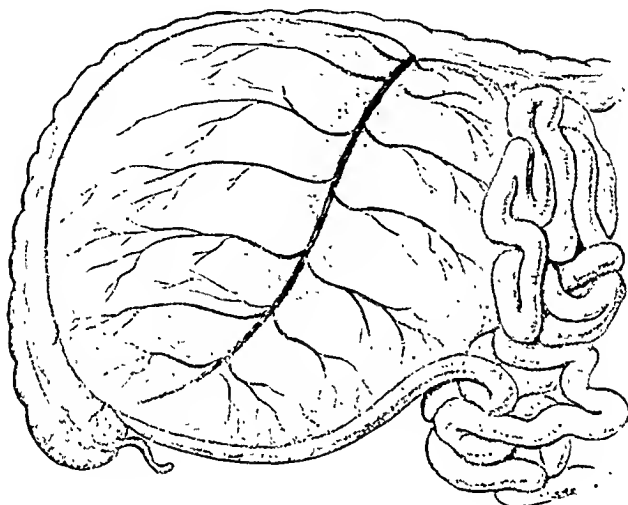


FIG. 79.—Mesenteric cyst (diagrammatic).

The child made an uninterrupted recovery, and was discharged on July 30. He was seen a month later, and was then quite well; the wound was firmly healed; there was slight thickening to be felt beneath the scar, but the abdomen was otherwise normal on palpation. He was seen again in April, 1924, when his condition was excellent.

PATHOLOGY.—The fluid removed from the cyst showed the characters usual in these cases, and the report was as follows: "Very bloodstained, specific gravity 1217, no trypsinogen, etc., no sugar or bile pigment, albumin present more than 4 per cent". The sediment was chiefly blood, and the fluid was sterile on culture. A section of the cyst wall showed "a thick wall of fibrous tissue with an endothelial lining".

The features we wish to emphasize in this case are: the large size of the tumour, its lateral position and immobility, the doubt whether it was solid or cystic, and the presence of secondary smaller cysts.^{1, 2, 3} In other respects it was true to type, even in that a correct diagnosis was not made before operation.

Case 2.—(We are indebted to Mr. H. J. Waring for permission to publish this case.) C. C., a married woman, 45 years of age, was admitted to St. Bartholomew's Hospital on Jan. 28, 1921, with a history that eighteen years previously she had noticed a lump in the abdomen. This was said to have been diagnosed as oöphoritis; the swelling was thought to have disappeared, and the patient remained quite well until 1911, when the swelling reappeared. In August, 1920, there was a sudden

increase in its size, accompanied by discomfort but not by acute abdominal pain: there were never any urinary symptoms; she had complained of irregular menstruation with increased loss since 1911.

EXAMINATION.—On inspection of the abdomen there was a visible swelling in the right hypochondriac and right lumbar regions, the size of an ostrich's egg. It was fluctuant, there was a band of resonance between it and the liver, and on palpation the swelling could be distinguished from the liver. Although cystoscopy showed both kidneys to be working normally, it was thought that she was suffering from a right-sided hydronephrosis.

OPERATION.—On Feb. 1, 1921, an exploratory operation was performed through a right lumbar incision by Mr. Harold Wilson. A large cystic swelling was found lying in the perinephric tissue in relation to the upper pole of the right kidney. It was not attached to the kidney or suprarenal body, and lay outside the tunica propria of the former. Seven pints of greenish-brown fluid were evacuated through a cannula, and the cyst wall was dissected out and removed. The wound was drained for twenty-four hours, and was healed when the patient left the hospital three weeks later.*

PATHOLOGY.—A section of the cyst wall showed "purely inflammatory structure with no evidence of renal tissue". The fluid removed at operation possessed a greasy sheen and contained cholesterol crystals. Its specific gravity was 1020, the reaction was neutral, and the fluid coagulated spontaneously on standing. On culture it proved to be sterile. It contained red blood-corpuscles and a considerable quantity of albumin, and effervesced with sodium hypobromite.

Although the last statement is evidence of the presence of urea, it does not prove that the fluid in the cyst was derived from urine: it is well known that the blood, cerebrospinal fluid, saliva, and probably most of the other body fluids contain urea, but that the percentage in urine is five to ten times that in the blood (20 to 40 mgrm. per cent in health). We have no quantitative figures on the interesting question whether the cyst contents were in this respect nearer blood or urine, nor has this point been investigated, so far as we know, in other cases. The only observation we have found in this relation is that of Jones,¹ who found urea 0.3 per cent in fluid from a mesenteric (not pararenal) cyst. This is, approximately, the same as in blood. The case we have described was labelled 'pararenal cyst', but its exact pathology remained in doubt.

GENERAL REMARKS ON MESENTERIC CYSTS.

ETIOLOGY.

What is meant by the term Mesenteric Cyst?—It often happens, when a condition of obscure origin is under consideration, that the nomenclature and classifications in general use are as diverse and unsatisfactory as the attempts to explain the disease, and it is certainly so with mesenteric cysts. Broadly speaking, any cyst occurring between the layers of, or in close relation to, the mesentery might be included under the heading 'mesenteric'. Thus, many of the published classifications embrace a variety of cysts (e.g., hydatid, malignant, and dermoid) whose only common attributes are their cystic character and intramesenteric position. Hæmatomata of the mesentery, which

* On Nov. 11, 1923, the patient wrote that she was perfectly well.

may follow injury in the absence of a pre-formed cyst, certainly account in rare instances for mesenteric tumours, but they are not true mesenteric cysts and only call for consideration in differential diagnosis. Such adjectives as lymphatic, chylous, sanguineous, though frequently used, merely denote accidents which may befall any cyst, and though picturesque they have no precise bearing on the problems of etiology and serve no useful purpose. It is therefore necessary to extract from the general mass common to all classifications the group of what may be called 'true' mesenteric cysts, for it is with this group only that we are now concerned. Before proceeding to this, it is convenient to consider some of the classifications which have been suggested, and three of the simpler and more recent of these are given below.

1. In 1900 Dowd⁵ published an important paper and adopted the following :—

- a. Embryonic cysts.
- b. Hydatid cysts.
- c. Cystic malignant disease.

This was amplified by Ayer,⁶ who added two more groups :—

- d. Cysts arising from the glandular structure of the intestinal wall.
- e. Cysts of the normally placed retroperitoneal organs.

2. Niosi⁶ in 1907 subdivided Dowd's embryonic group thus :—

- a. Cysts of intestinal origin : By sequestration from the bowel during development ; From Meckel's diverticulum when it arises from the concave side of the gut.
- b. Dermoid cysts.
- c. Cysts which spring from retroperitoneal organs (e.g., germinal epithelium, ovary, Wolffian or Müllerian bodies).

3. A more recent classification, that of Carter,⁸ though evidently based on Dowd's, is as follows :—

- a. True mesenteric cysts : Embryoecystomata ; Enterocystomata ; ? Obstructive.
- b. Dermoids.
- c. Cystic malignant disease.
- d. Parasitic.

We are not here concerned with parasitic or cystic malignant disease, and they may be dismissed. So also may true dermoids ; but it is interesting to notice in passing that no retroperitoneal or mesenteric dermoids have been reported in the male,^{6,9} though they have occurred in the testis,⁶ which is originally a retroperitoneal organ ; this has been held as evidence that an ovary is responsible for the true dermoid when it occurs in the mesentery.

True Mesenteric Cysts.—We have now restricted our field to those cysts which occur in or near the mesentery and which are not malignant, dermoid, or parasitic, and do not arise in any normally placed retroperitoneal organ. It is to the origin of these that we must now turn our attention. They have been found at every time of life, from the foetus to 80 years of age, though most commonly from 10 to 20 years, and occur in both sexes, with a slight preponderance of female over male. They are usually found

near the terminal portion of the ileum, though they have also been described in the mesentery of the jejunum, the cæcum, and appendix, and all parts of the colon; at least one occurred in close relation to the stomach.¹⁰ Of 28 cases published between 1900 and 1912, all were in the mesentery of the small bowel, with a proportion of ileum to jejunum of about 3 to 1.¹¹

The cyst often possesses an epithelial lining, though this is by no means invariable, and in a large cyst is frequently destroyed, presumably by the internal pressure exerted upon its walls; in one specimen the lining epithelium remained only here and there.¹² When present it is generally of simple columnar type, but may be stratified, or rarely ciliated.¹¹ The wall of the cyst varies in thickness and composition; fibrous tissue predominates, but there may be a few unstriped muscle fibres or occasionally a complete reproduction of the structure of some part of the alimentary tract (*vide infra*). The typical fluid¹³ from a mesenteric cyst is "a pale, clear, straw-coloured fluid of specific gravity 1015 or 1016, contains a large amount of albumin, and is alkaline in reaction". Blood, cell debris, and cholesterol are also usually present. Multiple cysts are rare, though cases have been recorded, by Makins¹ amongst others.

What is the origin of these cysts?

1. LYMPHATIC.—For many years the accepted idea was that they arose from obstruction and subsequent dilatation of a lymph-vessel in the mesentery. This view has been largely discarded in England and America, but, until recently, had its adherents in France.^{13, 14}

2. WOLFFIAN REMNANT.—In 1900, Dowd⁵ reintroduced and elaborated the suggestion that these cysts are due to inclusion of remnants of the Wolffian body in the developing peritoneal folds. Eight years previously, Braquehay¹⁵ had stated that "they" (i.e., congenital mesenteric cysts) "may come from rests of the Wolffian body", and had referred as authority to Auganeur's *Thèse d'Aggrégation* (Paris, 1886); but it was Dowd's paper that focused attention upon the subject. Dowd gave instances of sequestration in many organs, and concluded that these cellular relics behind the peritoneum might push their way between the leaves of the mesentery, and—liable as they are to undergo cystic degeneration—might give rise to cysts in the position in which they are usually found. He attributed the origin of most true mesenteric cysts to this developmental accident, but admitted that some might arise as diverticula from the intestine. This view has met with general favour and has been widely accepted, though some writers¹² regard the developmental error as primarily "an anomaly in the coalescence of the peritoneal mesenteries". Niosi⁷ described a case in which he found nodules of suprarenal tissue in the walls of a mesenteric cyst, but this would be more illuminating if it were not, as it seems to be, a unique observation. The fact that the cyst is so often solitary appears to us to afford definite support to the view of their origin held by Dowd.

3. DIVERTICULA.—

a. *Intestinal*.—There is, however, good evidence that some of these cysts arise as diverticula from the intestine: these are enterogenous cysts, and constitute the group of 'cysts of intestinal origin' in Niosi's classification (p. 98) and the 'enterocystomata' in that of Carter (p. 98). This is a serious

rival to the 'embryonic' view, and requires further notice. It has been shown that intestinal diverticula occur regularly in the embryo of the pig, rabbit, and man. In one human embryo of 23 mm., Lewis and Thyng¹⁶ found 33 'pockets', and in an older specimen 48. These were all diverticula of the small intestine, and in no human embryo did these authors find them along the border of the large intestine or vermiform process. Again, Wallmann¹⁷ found 37 diverticula in a piece of small intestine 48 cm. long, and 30 of these were between the layers of the mesentery; but he also found some present in the large intestine. The duodenum is perhaps the commonest situation, and it is said that diverticula here occur frequently.¹⁸ Since intestinal diverticula do occur in the human embryo, it requires no great imagination to suppose that, lying between the layers of the mesentery, they might become separated from their origin and form true mesenteric cysts.

Miller's case¹¹ seems to prove that this does occur: a female infant of four days died from a volvulus caused by a mesenteric cyst whose lumen did not communicate with the gut, but whose wall was directly continuous and identical in composition with the small intestine, from which it had undoubtedly arisen as a diverticulum. Other good examples of enterogenous cysts are given by Hunter¹⁹ and Van der Bogert.² It may be difficult in some cases, where a few scattered plain muscle fibres are present in a wall of a cyst, to decide whether or not it is enterogenous; but when a regular arrangement of muscle fibres at right angles to one another can be demonstrated, and when the structure of the alimentary canal is exactly reproduced, even to the presence of villi on the inner wall of the cyst, there is a very strong presumption that it arose in this way.

b. Meckel.—Cysts might arise enterogenously in a second way, from a persistent Meckel's diverticulum, or from a persistent portion of the vitelline duct. This is a structure whose position varies, for it may "originate from any part of the gut and apparently from any aspect" (Miller, *loc. cit.*); but its average situation is stated to be 43 inches proximal to the ileocaecal valve. Although Meckel's diverticulum is present in only 2 per cent of individuals, there is no authority for thinking that microscopic remnants of the duct are as rare. In order that this explanation may be applied to cysts between the layers of the mesentery, it is necessary that the duct should have arisen on the concave side of the intestine.

Thus, if the enterogenous cysts be considered to arise both as intestinal diverticula and as growths from vitelline duct remnants, a situation "in the upper bowel would favour the former, and in the lower bowel the latter" (Miller, *loc. cit.*). This statement can only be applied to cysts arising in the true mesentery, but it is exceptional to find them elsewhere. In a recent paper in the *BRITISH JOURNAL OF SURGERY*, MacAuley²⁰ described a case of congenital ileocaecal cyst, and gave particulars of ten others dating from 1886 which he regarded as forming a definite group. In his example the cysts were almost all near the ileocaecal angle, and probably most of them arose from the ileum. It seems possible that these are enterogenous cysts which have pushed their way into the lumen of the gut. Their walls seem similar to those of the enterogenous cysts cited above, and Ayer's case,⁶ which MacAuley gives as one of his series, was anatomically outside the caecum.

MacAuley, however, distinguishes them from other mesenteric cysts, though he does not consider their pathology. Professor Sir Arthur Keith, who reported on the specimen, regards it as an enterogenous cyst, but does not discuss its relation to mesenteric cysts.

Summary.—

1. True mesenteric cysts are not malignant, parasitic, or dermoid, but form a separate group in which are included the majority of all 'mesenteric cysts'.

2. Their origin is still in doubt, but it seems probable that there are two classes:—

a. Cysts of embryonic origin arising from mesodermal remnants incarcerated behind the developing peritoneum and subsequently migrating forward between its layers.

b. Cysts of intestinal origin: (i) Arising in most cases as diverticula from the bowel during development; (ii) Possibly derived sometimes from persistent portions of the vitelline duct.

3. Some anomalous and hitherto unclassified cysts, such as the 'pararenal' example described as *Case 2*, are true mesenteric cysts which have developed from mesodermal remnants behind the peritoneum, but which, unlike the ordinary clinical mesenteric cyst, have not moved anteriorly into the developing peritoneal folds.

It is important to distinguish the cysts of which we speak from the large cysts of the kidney which occur generally singly and quite apart from chronic nephritis, congenital cystic disease, and echinococcus infection; these are cysts of the kidney substance proper, and may communicate with the pelvis or contain fluid closely allied to urine, whereas the pararenal variety is definitely outside the kidney, and, though they may indent its substance, are not attached to it, and contain the characteristic fluid previously described. Pararenal (or paranephric) cysts are very rare, and have received scant notice in the text-books. There is no mention of them in *Keen's Surgery*, and only a few lines in some of the standard works on urology. Thus, Morris, Garceau, Thomson-Walker, and Kidd all refer briefly to them, and allude to a possible origin from Wolffian body remnants; but no attempt seems to have been made to associate them particularly with mesenteric cysts, nor does their close resemblance, and that of their contents, to mesenteric cysts seem to have received due notice.

SYMPTOMATOLOGY AND DIAGNOSIS.

The clinical aspects of these cases are of considerable surgical interest, and accord with the size, situation, and character of the cyst. Quite often the picture is that of a symptomatically silent abdominal tumour, though if this is of large size there may be associated discomfort. On the other hand, signs of subacute intestinal obstruction may be present, viz., attacks of distention associated with colicky abdominal pain and vomiting. In either case acute symptoms may supervene at any time, and then indicate the onset of obstruction due to any of the complications. The classical clinical sign is the *tumour*; this corresponds in position to the anatomical site of the

mesentery, and is, generally, more or less central in position. It is smooth, rounded, and cystic, though this last point may not be easily determined in the case of a tense cyst felt through the abdominal wall. In the typical example the mobility of the tumour is the striking feature, and this is usually greater in the transverse than in the vertical direction, in accordance with its mesenteric attachment. General wasting is not a characteristic of the condition, even when a large tumour is present and obstruction of the lacteals might be expected.

The differential diagnosis may be considered briefly under two heads: (1) Diagnosis from other intra-abdominal tumours; (2) Diagnosis between individuals cysts.

In a typical case the situation, mobility, and general characters of the tumour may localize it with probability to the mesentery, and serve to distinguish it from other abdominal swellings, e.g., ovarian or kidney tumours. Its cystic character may also be clear, but even then the exact nature of the tumour can only be surmised. It should usually be possible to exclude parasitic and malignant cysts; but a tuberculous abscess in the mesentery may present all the features enumerated above, and indeed, in childhood at any rate, is the most common type of 'mesenteric cyst' to be exposed by operation!

An Italian writer²¹ has made the following pathetic pronouncement on the subject of the diagnosis of mesenteric cysts: we give Braquehay's French translation: "*Sans se torturer autant et inutilement l'esprit, la seule chose à faire est une laparotomie exploratrice*".

Though it is admittedly a very difficult diagnosis to make, yet there are cases where, once suspected, a mesenteric cyst should be diagnosed. Obviously the attempt ought always to be made.

COMPLICATIONS.

Because of their surgical importance it is necessary to enumerate the complications to which these cysts are liable. Often enough it has been at operation on a puzzling 'acute abdomen' that the existence of an unsuspected mesenteric cyst has been revealed.

1. Intestinal obstruction is the most frequent and the most serious of the common complications. In a small series¹¹ of 17 enterogenous cysts, acute obstruction occurred in nearly 50 per cent, whilst the group mortality of 35 cases of obstruction due to this cause was 35 per cent. The methods by which it may be brought about are mechanical, and include volvulus, intussusception, kinking, adhesions, and a narrowing or occlusion of the gut by pressure of the tumour or stretching of the intestine over it.

2. Peritonitis, when it occurs, is a sequel to the above.

3. Hæmorrhage into the cyst has caused death.¹⁴

4. Rupture of the cyst may also cause death (Timbal, loc. cit.); but there are two cases of recovery^{22, 23} following what seems to have been spontaneous rupture of the cyst into the bowel.

5. Torsion of the cyst.

6. If a mesenteric cyst occupies the pelvis, it may itself become impacted, or may give rise to symptoms varying with the organ upon which it presses.

TREATMENT.

It has been stated above that spontaneous recovery has followed rupture of a mesenteric cyst; nevertheless it is clear that surgical treatment is called for in every case, even though an exact diagnosis may not have been made before operation. The treatment required is governed by the urgency of the case, thus:—

1. **The Acute.**—This comprises the abdominal emergencies which may be due to any of the complications already enumerated; treatment in such cases follows the ordinary lines without necessarily permitting an attack on the causal cyst.

2. **The Subacute or Chronic.**—In this group are the ordinary uncomplicated cases; these require an operation for the removal of the cyst, or, if this is impossible, some procedure which will relieve symptoms and give hope of cure. The following methods have been used:—

a. Aspiration.—This is no longer practised except as a stage in more radical operations.

b. Enucleation of the Cyst.—This is the ideal treatment, but is not always possible.

c. Resection of the Involved Segment of Intestine.—Partial resection is sometimes necessary to extirpate a cyst, but it is a severe undertaking, and in these cases carries a mortality of 60 per cent.¹¹

d. Drainage by Marsupialization.—The cyst wall is sutured to the abdominal parietes, and some operators, hoping to induce adhesions and obliteration of the cavity, apply caustics to the wall of the cyst.

Certain objections have been raised against enucleation and marsupialization: these may be set out as follows:—

Objections to Enucleation.—(a) That it is a more difficult and dangerous operation than marsupialization; (b) That it is sometimes impossible to accomplish because of extensive adhesions, the large size of the cyst, or its intra-intestinal position; (c) That it is liable to damage the intestinal vessels and nerves; (d) That it may injure the solar plexus. We have been unable to find statistics on the operative mortality sufficiently recent to be of value. Braquehay, in 1892, gave that of enucleation as 40 per cent, and of drainage as 6 or 7 per cent: but Miller (*loc. cit.*), in 1913, records ten enucleations without a death, and simple drainage must nowadays have a very low mortality.

Objections to Drainage by Marsupialization.—(a) That the cyst wall is not removed and that there is consequently no guarantee of cure; (b) That convalescence is long and a persistent sinus may result; (c) That post-operative complications are liable to follow, notably intestinal obstruction. The first and third would be serious disadvantages if they occurred at all frequently; but cure is almost invariable, and post-operative complications are extremely rare.

Summary.—

a. Either simple enucleation of the cyst or marsupialization of its wall, and drainage of the cavity, should be practised in every uncomplicated case.

b. Enucleation is the operation of choice, but only when it can be done without resort to intestinal resection.

c. Marsupialization and drainage should be performed in the remaining cases. It is an old operation—Péan in 1880 is said¹⁵ to have been the first to establish it as the appropriate surgical treatment for mesenteric cysts—but it is easy, safe, and universally applicable.

Care should be taken not to overlook undrained loculi or secondary cysts, and strong caustics should not be used.

CONCLUSIONS.

1. True mesenteric cysts are to be distinguished from other cysts found in the mesentery; their occurrence in this situation is not a topographical accident (cf. hydatid and malignant disease), but bears an important relation to their etiology and pathology.

2. To this group belong the greater number of mesenteric cysts.

3. Their origin is still in doubt, but the evidence that some true mesenteric cysts are enterogenous and arise primarily as diverticula of the alimentary tract is very strong and must be accepted.

4. The view which attributes the origin of enterogenous cysts to persistent remains of the vitelline duct is a possibility, although one restricted by the anatomical position of the duct. It cannot at present be considered proved.

5. The embryonic (Wolffian body remnants) explanation is attractive and applicable to a mesenteric cyst irrespective of its position. This view rests only upon strong probability, and is, by its very nature, difficult of proof; nevertheless it appears to us to afford the most plausible explanation of the origin in the majority of cases.

6. These cysts are diagnosed with difficulty, but they are amenable to surgery, although they are liable to cause complications which greatly increase the danger to life.

7. The first of the two patients whom we have described was found to have a typical though large mesenteric cyst. In the second the cyst was near the upper pole of the right kidney, though it was clearly not attached either to the kidney or to the suprarenal body; its macroscopic and microscopic characters were identical with those of a mesenteric cyst. We suggest that this also was an example of so-called mesenteric cyst, and that it arose from remains of the Wolffian body, and hence came to occupy a situation in close relation to the kidney. If it is admitted that this cyst, which bears such a close resemblance to the mesenteric cysts, arose in this way, then it seems to lend additional support to Dowd's explanation of the origin of mesenteric cysts.

8. Whether or not this is so, the term mesenteric cyst is a bad one, even when applied to the true cysts which we have discussed. Cunéo¹² in 1909 suggested 'paraperitoneal' as an improvement in nomenclature, and, if further

investigation should reveal a common pathology for some of the ill-defined varieties of retroperitoneal cysts, it may be that this word will be usefully employed in a wider sense than its author intended.

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ON THE ATTEMPTED PRODUCTION OF AN 'ASCENDING' RENAL INFECTION IN RABBITS.*

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It was shown by one of us (D.) in a previous communication¹ that, using the *Staphylococcus aureus*, it was an easy matter to bring about an infection of the kidney in the rabbit by way of the blood-stream. The present series of experiments was undertaken with the view of ascertaining if it were possible to bring about an 'ascending' infection of the kidney, using the term in the sense of an infection passing with the urine by a reversal of the usual direction of flow from the bladder into the ureter and thence into the renal tubules. The *Staphylococcus aureus* having, for reasons stated in the report, been used in the previous investigation, was also made use of in the present instance.

The problem naturally divides itself so as to fall under two heads: (I) The possibility of infection of the ureter from the bladder; and (II) The ureteric infection being established, whether it can pass by way of the lumina of the tubules into the kidney.

Various workers have obtained results indicating that fluid may pass from the bladder into the ureter with comparative ease. Thus Lewin and Goldschmidt² using milk, and Courtade and Albarran³ using Indian ink, reported that regurgitation took place from the bladder into the ureter in rabbits; and Kretschmer⁴ reported filling of the ureter from the bladder, demonstrable by X rays in four out of eleven children investigated. These results seemed to indicate that infection of the ureter from the bladder should be an easy matter. Such, however, was not found to be the case.

I. ATTEMPTED INFECTION OF THE URETER FROM THE BLADDER.

The first step was to produce a cystitis; this proved more difficult than was anticipated. The simple injection of organisms into the bladder was first tried.

EXPERIMENT 1.—One c.c. of a thick emulsion of *Staphylococcus aureus* in broth was injected by means of a glass catheter into the bladder of a male rabbit. Specimen of urine obtained by catheterization twenty-four hours later showed no pus-cells, but gave a free growth of the organism on culture. Seventy-two hours later a further specimen showed a diminished number of colonies on culture; one week later organisms were absent from the urine.

The experiment was repeated on several occasions and, although the length of time during which the organisms remained present in the urine

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differed in individual cases, the results were all substantially the same. The organisms disappeared from the urine in a few days, and none of the animals treated in this way showed any signs of illness.

Simple introduction of organisms into the bladder having proved a failure, so far as infection of that viscus, much more so of the ureter, was concerned, the question of applying trauma to the bladder with the hope of rendering it more susceptible to infection was next considered. The introduction of turpentine has been shown by various workers to be a highly successful agent for this purpose. The effects of this irritant are well described by David,⁵ and it is obvious from his account that the damage to the mucous membrane produced by it is such as to render infection of the blood-stream from the lumen of the bladder an easy matter. Since it was particularly desired to avoid any possibility of infection by this route, this agent was not employed. An attempt was made to provide a reservoir of organisms in the bladder, so that the viscus would be submitted to a continuous inoculation, the organisms in the reservoir being out of reach of the protective mechanism of the bladder wall. To this end a piece of porous earthenware soaked in an emulsion of living staphylococci was inserted into the bladder; but this was found to produce excoriation of the mucous membrane, which again introduced the possibility of spread of infection by the blood-stream. Choice was finally made of a piece of soft Turkey sponge. The following is typical of several experiments:—

EXPERIMENT 2.—Under ether anaesthesia the bladder was exposed by a suprapubic incision and opened transperitoneally through its anterior superior surface. The urine was swallowed out, and a piece of Turkey sponge about the size of a pea when compressed, but capable of expanding to about 2 cm. in diameter, was introduced. Ten drops of a thick emulsion of staphylococci in broth were allowed to fall upon the sponge, by which they were at once absorbed without having come in contact with the edges of the wound in the bladder wall. The bladder was then sutured with a seromuscular stitch, the suture line being covered by a small peritoneal fold containing fat, and the suprapubic wound closed.

Forty-eight hours later the rabbit appeared in fair health. Urine withdrawn by catheterization contained pus-cells and gave staphylococci on culture. On the fifth day from operation the animal was killed. On opening the bladder, which was contracted and contained very little urine, the sponge was not found, having apparently been voided: the mucous membrane was very swollen and oedematous; the ureters, kidneys, and all other organs showed nothing unusual, either to the naked eye or microscopically. Pus-cells were present in such urine as could be obtained from the bladder, and it gave a free growth of staphylococci.

It might have been anticipated that the above method of incising the bladder wall transperitoneally and then inserting a living culture of organisms would almost certainly give rise to peritonitis, or infection of the bladder wound, or both, with a consequent blood infection. It was hoped, however, that the organisms would remain in the sponge for an hour or so, and would not be diffused by urine all over the bladder, until the wound had had time to become sealed by clot. The success of this method was shown in practice in that, although the experiment was performed some six times for one reason or another, in no instance did the peritoneum become infected, and in only one did an abscess form in the bladder wound; this last case is described more fully later (*Experiment 6*).

The above experiment was repeated twice, and always with substantially the same results. In every instance an inflammation of the mucous membrane was produced, though in no instance was the sponge found in the bladder post mortem. Apparently the presence of the foreign body containing organisms in its mesh, even for the short time that it was in the bladder, was capable of rendering the mucous membrane susceptible to infection by the coccus. In every instance sections of the ureters and kidneys were cut and examined microscopically, but beyond some cloudy swelling in the tubular epithelium of the latter, no evidence of infection could be detected.

With a view to demonstrating the organism, if present at all in the kidneys, these were, in one case, removed immediately after death and incubated overnight in a sterile Petri dish; sections were then cut and examined for organisms. In the previous investigation one of us (D.) had found this to be a particularly successful method of demonstrating living cocci when present in the kidney, but in this case there was a negative result.

As it might be objected that sufficient time had not elapsed for infection to pass from the bladder to the kidneys, a vesical infection was produced in two rabbits (*Experiment 3*) in the manner described above, and the animals were allowed to survive. Pus-cells and organisms had disappeared from their urine by the *tenth day*, and, at post-mortem at the end of a month, the kidneys of both were perfectly normal.

The above experiments showed that, whatever may be the case as to passage of urine from the bladder back into the ureters, the production of infection in this way does not occur readily, if at all. David thought that he secured evidence of infection in this way; but, as pointed out above, he used turpentine to render the bladder susceptible to infection, thereby opening the road for blood-borne infection to take place. It is noteworthy that Draper and Braasch⁶ could find no evidence of regurgitation from the bladder into the ureter, even when considerable pressure was used, and after slitting up the mouth of the ureteric opening in the bladder wall. They attached even more importance to the sphincteric activity of the lower end of the ureter than to the valvelike arrangement of the opening of the ureter into the bladder.

Carmine Injection into Bladder.—In one experiment a tentative effort was made to effect the passage of an easily recognizable inert substance from the bladder into the ureter, as follows:—

EXPERIMENT 4.—Under ether anaesthesia the bladder of a large rabbit was exposed; it was found dilated with urine; 1 c.c. of a thick emulsion of carmine was introduced by means of a catheter, and the urethra ligated. The abdominal incision was temporarily closed, and the animal kept under light ether anaesthesia for four hours. At the end of that time the bladder was again exposed, and found to have become considerably more distended with urine. The ureters showed no signs of dilatation. The rabbit was killed and, in order to prevent any relaxation of the vesico-ureteric opening after death, plunged at once into Kaiserling's solution. When thoroughly fixed, the bladder and ureters were opened. No trace of carmine staining was present in either ureter, indicating that, in spite of the tension in the bladder caused by obstruction of the urethra, no regurgitation of the urine had occurred.

Such a single experiment cannot be conclusive, but it agrees with the findings of Draper and Braasch.

Effect of Trauma on Susceptibility of Kidney to Infection of Bladder.

—Attention was now directed to the effect of trauma in rendering the kidney susceptible to infection from an infected bladder.

A subtle form of trauma seemed to be offered by temporary or permanent occlusion of the ureter. Lepper,⁷ using *B. coli*, found that, although organisms injected into the blood-stream in the dosage used by her did not, under ordinary circumstances, make their appearance in the urine, they did so if the ureter of one kidney were temporarily occluded; this she believed to be due to trauma caused to the kidney by even temporary closing of the ureter. Some evidence as to the nature of this trauma is given later. The following experiment was performed:—

EXPERIMENT 5.—Under ether anaesthesia the ureter was exposed through a median abdominal incision, and a bulldog clip applied at about its middle. The wound was then partially closed, but in such a manner as to leave the handle of the clip protruding, and 1 c.c. of an emulsion of staphylococcus was introduced by catheter into the bladder. The wound with the clip protruding was covered by a sterile dressing, and the animal left for one hour. At the end of that time the clip was removed and the wound finally closed. Forty hours later urine removed by catheterization showed no pus-cells and gave only a few colonies of staphylococci on culture. Thereafter specimens of urine showed nothing abnormal.

This experiment was repeated once. On killing the second rabbit, some scarring and consequent contraction of the ureter at the site of application of the clip, but insufficient to cause complete occlusion, was found; the ureter above this point, and the pelvis, were both somewhat dilated, but there was no sign of infection of the kidney.

On the assumption, which as subsequent experiments showed was not justified, that any trauma to the kidney produced by obstruction of the ureter would be progressive, it was now determined to infect the bladder, to give the infection ample time to reach the lumen of the ureter, and then to ligate that structure. It was hoped that the disturbance produced by the obstruction of the ureter would be effectual in bringing about a renal infection.

EXPERIMENT 6.—In the manner described above, a cystitis was brought about by the introduction of infected Turkey sponge. Five days later, under ether anaesthesia, and through a median incision, the left ureter was ligated in two places and a portion removed from its middle. The wound was then closed. Eight days later the animal, which for some days past had shown signs of illness, was killed. At autopsy the left kidney was found to be greatly enlarged and to show collections of pus beneath the capsule; the pelvis and ureter were both enormously dilated. On section, the dilated pelvis was found to be filled with pus, and areas of suppuration were apparent tracking through the kidney substance from pelvis to capsule, under which were several abscesses of all sizes. Three septic infarcts were to be seen in the substance of the kidney (Fig. 80).

Cultures of pus from the left pelvis gave a free growth of *Staphylococcus aureus*; cultures from the heart blood and right renal pelvis were sterile. From the bladder urine, staphylococci were grown.

On opening the bladder, an abscess was found surrounding the sutures in the wall of the organ.

In this experiment a severe infection of the kidney had been brought about; as to the mode of this infection, there were two possible explanations. In the first place, it might be assumed that the coeci had made their way from the bladder into the ureter before it was ligated, and that after occlusion of that structure they had produced the infection of the kidney, weakened as a result of the operation. This explanation is hardly probable, inasmuch

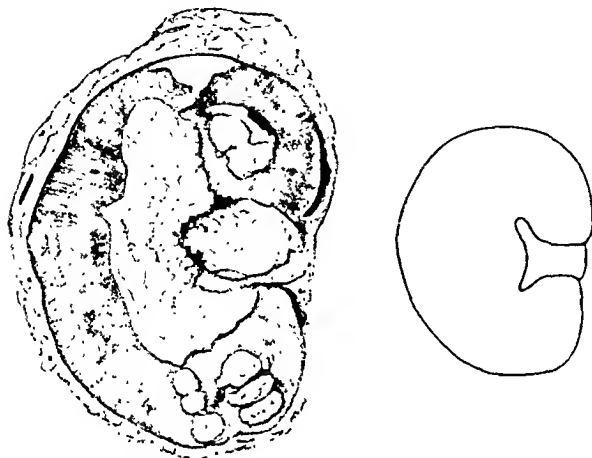


FIG. 80.—Abscess formation in *Experiment 6*. Outline figure shows size of unaffected kidney.

as the segment of ureter removed five days after the bladder was infected was quite normal on microscopical examination, indicating that no infection was present in the ureter at the time that structure was ligated. In the second place, the renal infection might be explained as having been borne from the abscess in the bladder wall by the blood-stream. The presence of septic infarcts in the kidney offered support to this second view.

This experiment was repeated, and in three other experiments (7, 8, and 9) the infection of the bladder was brought about at the same time, two days and one week respectively prior to the occlusion of one ureter. *Experiments 8 and 9* were each performed twice. In none of these further experiments was an infection of the kidney procured, and in none of them was any infection of the operative wound in the bladder present, such as was described under *Experiment 6*.

Early Changes in Kidney following on Occlusion of Ureter.—At this point it seemed desirable to obtain some first-hand information as to the more immediate effects of occlusion of the ureter upon the kidney. In *Experiments 10 to 15*, the ureter was exposed under ether anaesthesia through a median incision and a ligature applied at the junction of the lower and middle thirds. This procedure was carried out without in any way touching either the kidney itself or its vessels. The importance of this is indicated hereafter. The abdominal wound was then closed, and the animals were allowed to survive for one hour, two, three, and five days, and one and two weeks respectively. In every instance the animal was killed at the end of the time stated, the kidney removed at once and put into Kaiserling's solution, and only sectioned after it had become hard.

EXPERIMENT 10.—Animal killed one hour from time of obstruction of the ureter. On cutting open the kidney after fixation, the pelvis and ureter were found greatly dilated. The renal papilla was flattened out and the medulla compressed, but the cortex showed no diminution in thickness. On microscopical examination the most striking change was the presence of numerous areas of hæmorrhage; these

were most plentiful in the cortex and boundary zone, and appeared to be due to the rupture, following upon overfilling, of the intertubular capillaries; the presence of great engorgement of the veins in conjunction with comparative emptiness of the arteries suggested obstruction of the venous outflow as the cause of these hæmorrhages. So far as could be ascertained, this obstruction was due to pressure exerted by the tense walls of the greatly dilated pelvis upon the arcuate system of veins in the kidney. The tubules of cortex and medulla alike were greatly dilated, obviously as the result of the pressure of the secreted urine within them.

EXPERIMENT 11.—Animal killed twenty-four hours from time of ligation of the ureter. Macroscopically the appearances were very similar to those in *Experiment 10*. The walls of the pelvis were greatly swollen and dark red in colour, and the urine retained in the pelvis was dark brown and contained many red blood-cells. Microscopic examination showed no increase in the areas of hæmorrhage described under *Experiment 10*, but in other respects they revealed a further advance of the state of affairs seen after one hour's ligation: the dilatation of the tubules, more particularly those of the cortex, was greatly increased; the medulla showed further signs of the influence of the pressure exerted by the contents of the dilated pelvis, the tubules in this area, as they approached the papilla, showing a sharp bend due to the stretching of the medulla and flattening of the papilla; this bend had apparently resulted in the occlusion of the tubules, thus, to a large extent at any rate, cutting off the lumina of the cortical tubules from any direct connection with the cavity of the pelvis.

EXPERIMENTS 12, 13, 14, 15.—Ureter obstructed for three, five, and seven days, and two weeks. Macroscopically these all showed the same features as described under *Experiments 10 and 11*. The pelvis showed little increase in size in any of these experiments on that attained after twenty-four hours' obstruction; the substance of the kidney itself, however, showed a slowly progressive dilatation, accompanied by great stretching and flattening of the medulla, though even after two weeks' obstruction a deep strip of cortex remained, spread out over the dilated renal sinus. After the third day the venous congestion became progressively less and less, while the areas of hæmorrhage had completely disappeared at the end of a week—apparently as the result of absorption. By the end of two weeks the dilatation of some of the tubules of the cortex had become extreme; others were compressed and had their lumina occluded; the compressed tubules tended to occur in well-defined areas, mapping out the areas in which dilatation of the tubules had occurred, the result of this arrangement being to give a honeycomb appearance to sections of the cortex as viewed through a hand lens. This progressive dilatation of the tubules speaks for a continued secretory activity on the part of the kidney. The urine thus secreted being to a large extent retained in the tubules as the result of the flattening of the medullary tubules and their angulation, as pointed out under *Experiment 10*. The cells of the dilated cortical tubules were flattened, but otherwise appeared healthy; the epithelium of the compressed tubules also stained well, but in some of the tubules the basement membrane had disappeared, presumably indicating the first step towards the dissolution of these tubules. The glomeruli showed no dilatation.

The above experiments show that the most striking of the more immediate effects of obstruction of the ureter on the kidney is not, as might be expected, the onset of a progressive degeneration of the secreting tissue, but, on the contrary, an almost immediate, sudden trauma in the shape of interstitial focal hæmorrhages, with a strong tendency to recovery. In order to be sure that these hæmorrhages are due directly to ligation of the ureter, it is, of course, essential to ligate that vessel as is described above, without handling the kidney. Any such method as delivering the kidney through a loin incision preparatory to ligating its ureter produces extensive hæmorrhages and masks

the effect of the ureteric ligature. This production of traumatic hæmorrhages must be borne in mind in all experiments upon the kidney involving ligature of the ureter, and, taking it into consideration, the most probable explanation of the infection of the kidney in *Experiment 6* would seem to be that it was carried by way of the blood-stream from the abscess in the bladder to one of the hæmorrhagic areas in the renal substance.

II. INFECTION OF THE KIDNEY FROM THE URETER.

Attempts at producing an 'ascending' infection of the urinary tract from the bladder having given only the above negative or equivocal results, attention was now directed to the possibility of the passage of infection from the ureter into the kidney.

EXPERIMENT 16.—Under ether anæsthesia the ureter was exposed through an abdominal incision and ligated at the junction of the lower and middle thirds. A glass cannula was inserted into the proximal end of the ureter, and the ureter divided below the point of insertion of the cannula. The proximal end and cannula were brought out through the abdominal wound, which was then sutured and sealed with collodion; 1 c.c. of an emulsion of *staphylococcus* was introduced through the cannula into the ureter, the ureter ligated just above the cannula, and the latter removed. The introduction of organisms into the ureter was carried out in this way to avoid contamination of the peritoneal cavity, which in no instance occurred. Forty-eight hours later the animal was killed. The kidney was found greatly swollen, with numerous and extensive subcapsular abscesses about the lower pole; in fact the condition closely resembled that of 'surgical kidney', with the difference that owing to the ligature of the ureter the pelvis was greatly dilated with pus.

The problem now was to determine whether the infection had 'ascended' in the strict sense of the term by way of the lumina of the tubules into the renal substance, or whether infection of the kidney had been the result of direct spread into the interstitial tissue; the appearances of abscesses under the capsule, while the main mass of pus was confined to the pelvis, suggested that a real 'ascent' of the infection might have occurred. Microscopic sections, however, did not confirm this view; these showed the medulla stretched out and compressed by the mass of pus and urine in the pelvis; the epithelium of the tubules in immediate relationship to this pus was necrotic, apparently as the result of spread of toxin into the tissues, the necrosis grading off into degeneration, and then into cloudy swelling, as the neighbourhood of the pus was left. In places the infecting cocci, by reason of the dissolution of the epithelial lining of the renal sinus, had gained access for a very short distance into the interstitial tissue of the medulla; but nowhere could pus-cells or cocci be demonstrated in the lumina of the tubules.

The abscesses under the capsule at the lower pole were found to be due to the direct spread of the infection from the pelvis through a rupture in the epithelium of the sinus, where it was reflected from the pelvis on to the papilla, and thence up under the capsule, without affection of the underlying cortex. It was conjectured that this rupture had been brought about by the use of too great an amount of emulsion for the injection, and of too great force in

its performance. This was confirmed in a further experiment (*Experiment 17*), in which only 0.2 c.c. of the staphylococcal emulsion was used; in this case, although the same infection of the pelvis was produced, the subcapsular abscesses were absent.

Carminic Injection into Ureter.—Since experiments with living cocci necessitated the early destruction of the animal, and moreover produced progressive changes of a rather uncontrollable nature, they were repeated using a suspension of carmine; the use of this material made it possible to leave the animal for as long as wished after its introduction, in order to give ample time for it to find its way from the pelvis into the kidney, were it capable of so doing.

In the first of these experiments, Nos. 18 and 19, 1 c.c. of the carmine, used in a heavy emulsion in distilled water, was introduced into the left ureter, which was thereafter ligated, in the manner described above; the animals were killed twenty-four and forty-eight hours respectively from the time of the injection. In both cases the appearances after death were very similar; but, since they were more striking in the rabbit which had been allowed to survive for forty-eight hours, this alone will be described. At post-mortem,



FIG. 81.—Mode of spread of carmine from pelvis out under the capsule in Experiments 18 and 19.

the pelvis and ureter as far as the ligature were found greatly dilated and filled with carmine; at the lower pole of the kidney was a deeply stained area caused by the appearance of the carmine beneath the capsule (*Fig. 81*). On laying the kidney open after fixation, it was apparent that this subcapsular staining had been produced by the direct passage of the carmine from the pelvis, out beneath the true renal capsule, without its having entered into the substance of the kidney at all. Macroscopically the kidney showed the usual flattening of the medulla, but no evidence of carmine within its substance.

On microscopic examination it was at once evident that, as in the first experiments in which living cocci were used, the amount of the injected material had been too great and that rupture of the epithelium lining the renal sinus had been effected (*Fig. 82*). It was through such a rupture that the carmine had passed out from the pelvis beneath the capsule covering the lower pole of the kidney. Microscopic examination of the sections showed rupture of the epithelium, not only at the junction of the pelvic wall and capsule, but also over the surface of the kidney bounding the renal sinus. At some of these points of rupture of the epithelium hæmorrhage had occurred, and in one of them a mixture of red corpuscles and carmine granules was to be

seen actually lying within the interstitial substance of the kidney (*Fig. 83*). Further examination of this kidney revealed granules of carmine lying within vessels, sometimes free, sometimes contained within the lining endothelium, and in many cases at some considerable distance from the site of the hæmorrhage; it was not possible in every instance to be sure if the vessels concerned were lymphatics or capillaries; some were undoubtedly blood-vessels, and the probability is that both were implicated. Furthermore, a number of the convoluted tubules in the immediate neighbourhood of the carmine-

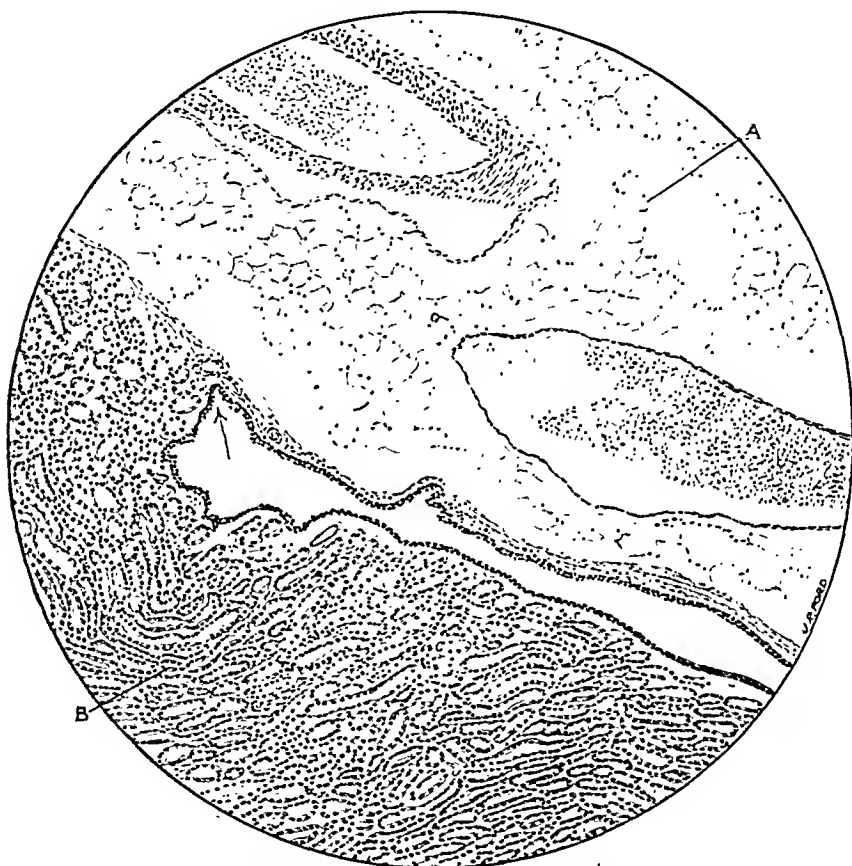


FIG. 82.—Reflection of epithelium of renal sinus from papilla (B) on to pelvic wall (A); the arrow shows site of rupture in *Experiments 18 and 19*.

containing hæmorrhagic areas showed numerous minute granules of carmine within their lining epithelial cells (*Fig. 84*). In no instance was a granule of carmine detected within the lumen of a tubule, though some of the tubules contained a pinkish homogeneous substance (*Fig. 84, A*) which may have been albumin stained by carmine secreted in solution in the alkaline urine and coagulated by the fixative. These appearances might seem to indicate that the carmine had been taken up by the blood or lymph or both from the carmine-containing hæmorrhagic area, and was in course of being excreted

by the tubular epithelium ; a more probable explanation is that the appearances were due to vital staining of the bioplastic granules of the epithelial cells by the carmine.

Whatever may have been the manner in which the carmine granules reached the epithelium of some of the convoluted tubules, it was quite evident that none of it had reached the interior of the kidney by passage from the pelvis up the lumina of the tubules.



FIG. 83.—Bursting of carmine through epithelium of renal sinus and into interstitial tissue of kidney in *Experiments 18 and 19*. Hæmatoxylin stain.

A further experiment, No. 20, in which only 0.3 c.c. of the emulsion was used and the animal was left for five days in order to give the carmine every opportunity of passing from the pelvis into the kidney, confirmed this view. In this animal no rupture of the epithelium of the renal sinus was found post mortem, and, although the pelvis was full of the emulsion, no trace of it could be detected in the kidney, either maero- or microscopically.

Burns and Swartz,⁸ using dogs, report that they found no difficulty in bringing about the passage of Indian ink from the ureter into the kidney.

They state that in animals killed half an hour from the time of the injection under a hydrostatic pressure of six inches of a small amount of this substance into the ureter, they were able to demonstrate the ink "in the collecting tubules, the distal convoluted tubules, the ascending and descending limbs of Henle's loop, the proximal convoluted tubules, the capsule of Bowman, in the spaces between the tufts of the capillaries of the glomeruli, and in the capillaries themselves".



FIG. 84.—High-power drawing of portion of Fig. 83 within circle, showing carmine-stained granules in epithelial cells. A, The pink substance referred to on p. 114.

The difference between these findings and those given above in connection with carmine injections is so striking that it was considered necessary to repeat the experiment, using Indian ink, with a view to ascertaining if there is any radical difference in the behaviour of the two substances.

In *Experiments* 21 and 22 Indian ink was allowed to flow by gravity from a height, in the one case of 6 inches, in the other of 9 inches, into the ureter, which had been cannularized. The pressure was kept up for half an hour, the animal being all the time under light ether anæsthesia. At the end of

this time the ureter was ligated, the animal killed, and the kidney removed and fixed. In both cases the findings were identical. The pelvis was filled with the ink, but the most careful microscopical examination failed to show the entrance of a particle of the injected material into the tubular system of the kidney.

DISCUSSION.

The uniformly negative result of all the experiments described above, performed with the view of bringing about the passage of cocci or carmine granules, or Indian ink, from the pelvis into the renal tubules, points to the conclusion that the renal papilla stands guard over the tubular system of the kidney, acting as a valve, passage through which in the reverse direction is a matter of impossibility. If the results described above are correctly interpreted, it would seem that an 'ascending' infection of the kidney, in the sense of the passage of infection from the pelvis into the renal tubules, can never take place.

In *Experiments 16, 18, and 19*, however, the possibility of infection of the kidney from the pelvis in a manner other than the direct passage of infected urine in the reverse direction into the renal tubules was demonstrated. These experiments showed that by a sudden increase of the fluid pressure within the pelvis it was possible to effect a rupture of the epithelium of the renal sinus. Such a rupture occurring at the junction of the pelvic wall and renal capsule allowed the passage of the pelvic contents outwards underneath the capsule, and in the presence of an infecting agent might give rise to a condition indistinguishable from a clinical 'surgical kidney'. It is probable that an increase in the pressure within the pelvis, to a height sufficient thus to bring about a rupture of the epithelium lining the renal sinus, could only be caused by a mechanical injection such as was used in the experiments. It is possibly conceivable that such an effect might be produced by a sudden stoppage of the urinary passages such as may occur with a stone in a ureter; but even that is conjectural. There can, however, be little doubt that in therapeutic irrigation of the pelvis through a ureteric catheter it would, by the use of sufficient force, be easy to bring about such a rupture of the epithelium of the sinus. It seems quite possible that exacerbations of renal infection such as are sometimes seen following on pelvic irrigation may be due to this cause. The experimental results provide indications for caution in so far as the volume of irrigation fluid used and the degree of pressure under which it is injected are concerned.

SUMMARY AND CONCLUSION.

A series of experiments is described, designed, if possible, to bring about an 'ascending' infection of the kidney, using the term 'ascending' in the sense of an infection passing into the kidney via the lumina of the urinary passages. Attempts directed to bring about infection of the ureter from the bladder showed that the uretero-vesical junction offered, under the experimental conditions, an insuperable bar to the passage of infection from the bladder upwards. By direct infection of the lumen of the ureter it was found

to be possible to bring about a subsequent infection of the kidney; but this infection was due, not to regurgitation of the infected pelvic contents into the renal tubules, but to direct spread through the epithelium of the renal sinus into the interstitial substance of the kidney, and under certain conditions, into the space between the kidney and its true capsule. Carmine injected into the pelvis did not pass through the renal papilla, which appeared to offer an impassable barrier to a reversal of the urinary flow.

No evidence could be obtained of the possibility of the occurrence of an 'ascending' renal infection.

The thanks of the authors are due to Sir Cuthbert Wallace, Director of the Surgical Unit, St. Thomas's Hospital, and to the Medical Research Council, without assistance from which the work could not have been carried out.

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RETROPERITONEAL CYSTS : THEIR PATHOLOGY, DIAGNOSIS, AND TREATMENT.

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(Being the Hunterian Lecture delivered at the Royal College of Surgeons of England on
Wednesday, Jan. 23, 1924.)

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-

I. INTRODUCTION.

It may perhaps be said with some justice that retroperitoneal cysts are of academic rather than practical interest; but I believe that they are of some importance, for several reasons. First, it will be generally agreed that the study of embryology is not sufficiently often referred to in dealing with the etiology of disease. We touch lightly, and not always very accurately, upon embryological facts for the explanation of such conditions as hare-lip, cleft palate, thyroglossal and branchial cysts; but there are undoubtedly many more complicated problems upon the etiology of which embryology may be expected to shed further light; and I am convinced that we are on the threshold of much important work based on the correlation of embryological and pathological methods. Many retroperitoneal cysts are developmental in origin, and I hope to show how a study of the processes involved sheds considerable light upon their origin. Secondly, these cysts are not common, and in the past but little work has been done upon them, and the literature on the subject is most confusing.

My attention was first directed to them by a case in St. Mary's Hospital, in 1920, and, as is the experience of us all, examples of rare diseases do not

come singly but in twos and threes. Three cases of retroperitoneal cysts were admitted within two months, and since then none have been seen, though I have personal knowledge of two others. The first case was impressed on my mind partly because of its intrinsic interest, partly because it was the first case of its type I had seen, and partly because it provided a dramatic diagnostic surprise. It may be conveniently quoted here, as it gives a graphic picture of these retroperitoneal cysts.

Case 1.—Female, 34, married, with two children, was admitted to St. Mary's Hospital with a history of vague pains in the left side of the abdomen. She had had a certain amount of trouble with the bowels for the previous month, necessitating the use of purgatives twice a week, but we were not satisfied that this was of any importance. She had also had frequency of micturition for about three months, which she described as coming in regular attacks with quite normal intervals. On examination, a swelling was found in the left side, being freely movable and easily reducible into the loin. It was soft, rather flabby, and obviously cystic in nature, and I think quite naturally a diagnosis of hydronephrosis was made. A pyelogram was accordingly taken, but unfortunately the plate was thin, and no definite expression of opinion could be hazarded upon it. It was, however, suggested that the solution seemed to have filled a very small part of the renal pelvis.

An exploratory operation was decided upon, and the left oblique lumbar incision performed. When the perirenal space was exposed, a bluish thin-walled cyst was found, and the diagnosis of hydronephrosis seemed assured. As the dissection proceeded, the surgeon remarked that the ureter would soon be found attached to the hydronephrosis. But the cyst shelled out revealing no attachments at all, and it was then realized that the kidney was present, rather higher in the abdomen than usual, and moreover was only half the normal size, thus explaining the unusual pyelogram.

This case illustrates in many ways the features characteristic of retroperitoneal cysts. The need exists for an accurate definition of the term 'retroperitoneal cyst', for so many cases are so named which are cysts of organs such as the kidney, pancreas, and so on. They are naturally situated behind the peritoneum, but I submit that the term should be reserved for those cysts lying in the retroperitoneal fatty tissues which have no apparent connections with any adult anatomical structure save by areolar tissue.

In this paper I shall deal with such cysts as I have defined above, except that I have a few remarks to make on some falsely-named pancreatic cysts, and also on two cystic conditions in the kidneys which are of developmental origin and are very closely related to the whole question of the true retroperitoneal cyst. I shall therefore outline quite briefly the embryological processes which are relevant.

II. DEVELOPMENT OF THE STRUCTURES OF THE POSTERIOR ABDOMINAL WALL.

1. The Pronephros.—The human pronephros has no excretory function, and can only be regarded as a rudimentary structure. Its appearance is but transitory, and its development is so incomplete that a clear idea of its life history is by no means easy to obtain, especially as it occurs in so very early a stage in the growth of the human embryo, being first seen in a 1.73-mm. embryo and having completely disappeared by the time the 4.9-mm.

stage is reached. A detailed account of its development would be quite out of place here, but certain of its salient features must be emphasized.

In lower forms the excretory system is essentially a segmental one, and the same tendency is seen in the arrangement of the human pronephros and mesonephros. The segmentation of the mesoderm begins at the head end of the embryo and proceeds caudally until complete. Pronephric rudiments have been seen by Felix⁷ and others in the 2nd primitive segments (*Fig. 85*). The cranial portion develops first, and so brief is the existence of the tubules that those first formed are already in an advanced stage of degeneration when the caudal ones are appearing. These latter are completed in an embryo of 2.5 mm. greatest length, and are already degenerated in one of 4.25-mm. vertex-breech length.

For the purpose of this paper two points are of the utmost importance, viz., the most caudal extension of the pronephric system, and the time of its complete disappearance. It is probable that no pronephric tubules exist beyond the 12th primitive segments, though there is some doubt about the 13th pair. The 12th segments will eventually correspond in the developing embryo with the opening of the bursa omentalis, and therefore pronephric remnants—if they persist—will be behind the peritoneum and are in a position to account for cyst-formations. In this connection it is instructive to remember that in the dogfish there are certain papillary projections from the posterior wall of the bursa omentalis, which Professor J. E. S. Frazer has described, and to which he has given an undoubted pronephric value. The time of disappearance of the pronephros is impossible of accurate determination, because in the caudal segments there is an overlapping of pronephric and mesonephric elements, and the picture is somewhat confused; but it may be said with some confidence that by the time the 5-mm. vertex-breech length stage is reached, the pronephros has disappeared. Nevertheless it is important to remember that the external glomerulus of the pronephric tubules may persist long after this stage, because of their independence.

2. The Mesonephros.—The development of the mesonephros is a vast subject, and the following description will be confined to a brief outline of its growth, its original extent, its two periods of degeneration, and lastly to its eventual adult representatives.

The mesonephros, developing from the mesoderm of the intermediate cell mass, is first seen in the 13th, 14th, and 15th segments in an embryo of 2.5 mm. greatest length (*Fig. 86*). These segments correspond to the 2nd, 3rd, and 4th thoracic segments. (From now onwards the segments will be

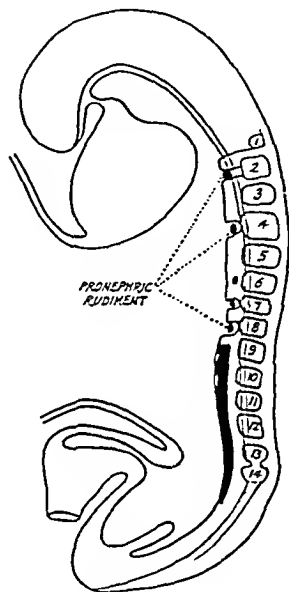


FIG. 85.—Diagram showing the left pronephric elements in an embryo of 2.6 mm. greatest length, with 14 pairs of segments. There are pronephric rudiments in the 2nd, 4th, 6th, 7th, and 8th, and the ridge from the 9th to 13th primitive segments. (*Modified from Felix.*)

denominated cervical, thoracic, and lumbar—the reader will remember that the first four pairs of primitive segments are taken up in the development of the head.) Growth occurs in both directions, for, in an embryo of 5.3 mm. greatest length, mesonephric tubules have extended to the 6th cervical segment, and in an embryo of 7 mm. the caudal limits of its extension have been reached, i.e., to the 3rd lumbar segment. It will be seen then that mesonephric elements are developed in the 6th cervical to the 3rd lumbar segments both inclusive, making a total of 18 segments. In these segments the development of the tubules is dysmetamerie, and several tubules are formed in each segment. Felix estimates that a maximum of 83 tubules are formed in each mesonephros.

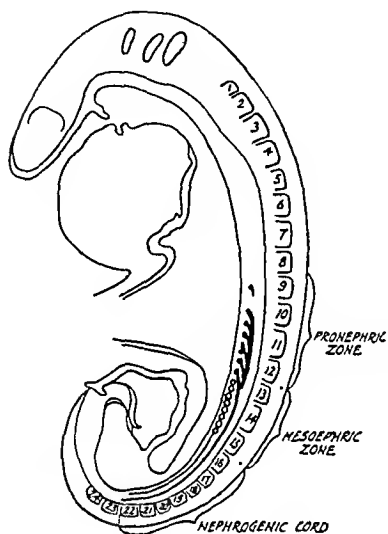


FIG. 86.—Diagram showing the left excretory apparatus of an embryo of 2.5 mm. and 24 pairs of segments. Pronephric elements can be seen in the 9th to 13th segments, mesonephric vesicles in the 13th to 16th, and, caudal to that, the part of the intermediate cell mass which will give rise to the rest of the mesonephros and the metanephros. (Modified from Felix.)

cases one of these may remain as a vestigial structure, and, should it do so, another possible origin of retroperitoneal cysts has been demonstrated (Figs. 87 and 88).

The second period of degeneration occurs later, and is concerned with the remaining 26 tubules, all situated in the lumbar region. The upper group, consisting of the 58th to 69th tubules inclusive, form the epigenitalis, and the lower group of the 70th to 83rd tubules, the paragenitalis. The former are intimately concerned with the development of the genital glands, and are of no importance here. For exactly the same reason the paragenitalis tubules in the male need no description; but in the female the various tubular structures formed in and near the broad ligament are all derived from these paragenitalis tubules. The structures referred to are included under the

The first period of degeneration begins before the caudal extension is complete, for as soon as the cranial tubules are fully developed they begin to degenerate. It therefore starts in the 5.3 mm. stage, and continues until the embryo has reached 21 mm. greatest length. Beginning in the 6th cervical segment, degeneration proceeds in a continuous and regular fashion down to and including the 12th thoracic; 15 segments therefore disappear, and only the three caudal ones persist. In terms of tubules, Felix⁷ estimates 57 out of 83 degenerate and should disappear entirely; but a most important fact is emphasized by Zuckerkandl,¹⁵ that remains of these tubules can sometimes be identified long after the normal date of their disappearance. For the purpose of this paper the foregoing facts are of very great importance. The mesonephros in the whole range of its development is lying in the retroperitoneum, and there are 57 tubules which should normally disappear. It is reasonable to suppose that in a certain number of

several names of paroophoron, Kobelt's tubules, etc. Certain retroperitoneal cysts in the pelvis undoubtedly arise in these mesonephric structures.

FIG. 87.—Diagram of the structures of the post-abdominal wall and the pericardium of an embryo of 16 mm., showing the ridge formed by the mesonephros on each side. The ridge is already dividing longitudinally into two, to form the genital gland. The extent of the mesonephros will be seen to be from the top of the retroperitoneum right to the pelvis.

A, Mesonephros; B, Genital ridge; C, Median mesentery; D, Genital tubercle. (Copied by Miss I. C. Mann from a drawing of Prof. J. E. S. Frazer.)

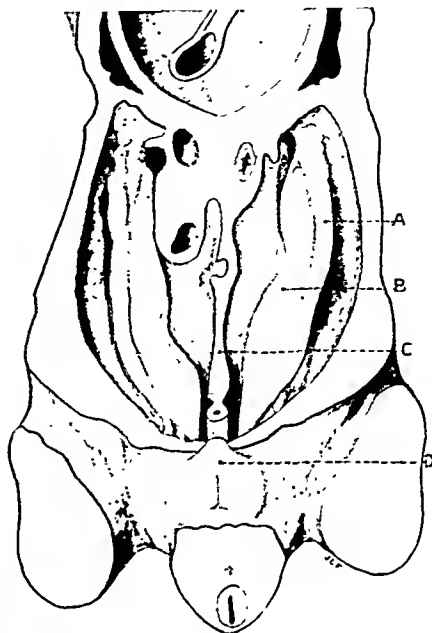
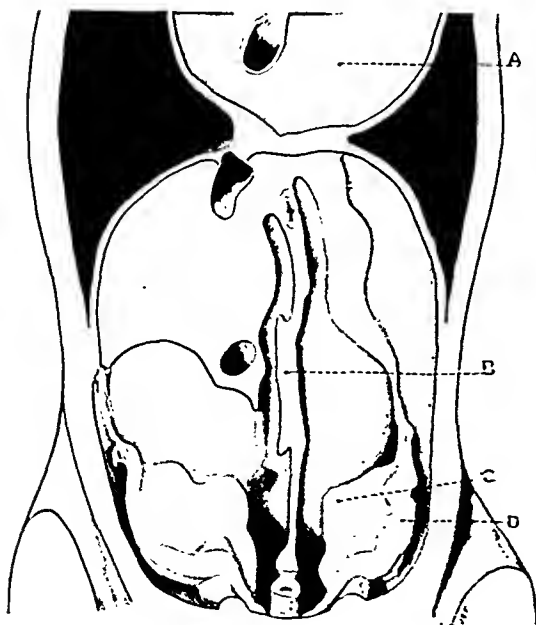


FIG. 88.—Diagram similar to Fig. 87 in an embryo of 28 mm. It shows the degeneration of the mesonephros, the marked growth of the suprarenal; and the line of disappearance of the mesonephros is seen to be from the lateral ligament of the liver down to the internal abdominal ring.

A, Pericardium; B, Median mesentery; C, Genital gland; D, Mesonephros. (Copied by Miss I. C. Mann from a drawing of Prof. J. E. S. Frazer.)



3. The Metanephros.—This arises from the nephrogenic cord in its caudal quarter, and is divided embryologically and physiologically into two parts—the excretory and the efferent. The efferent system develops from the Wolffian duct in the 5th lumbar segment, at the point where it turns horizontally forward to enter the lateral wall of the cloaca. From this origin the ureteric bud, first seen in embryos of between 4.5 and 5.3 mm. greatest length, grows at first dorsally towards the vertebral column, and then, gradually curving, grows cranially behind the mesonephros in the retroperitoneum. This cranial growth continues until it held up by the lateral outgrowths, which, acting as an anchor, prevent a further growth forwards (*Fig. 89*). By the 13-mm. stage, the adult position of the renal pelvis opposite the 2nd lumbar vertebra has been reached. Increase in length of the ureter occurs caudally, for it is in the lumbar region that the body growth principally takes place. The ureteric bud divides into two poles, and these begin growing on their

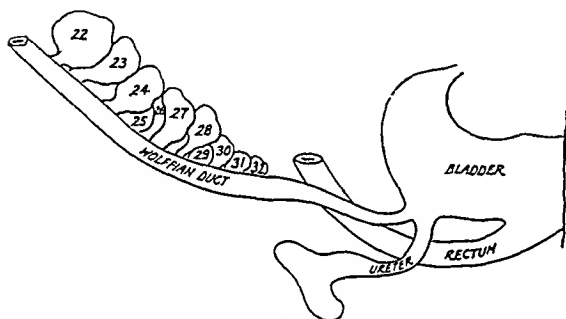


FIG. 89.—The right side of an embryo of 9.5 mm. greatest length, in which the ureteric bud has formed a primitive pelvis, and has divided into its first two tubules. (*After Felix.*)

own account; so are the collecting tubules of the first order formed. These again form collecting tubules of the second order, and so on and so on, until there are formed tubules of the 1st to the 12th order and terminal collecting tubules. The final completion of this series occurs during the fifth month.

The excretory system arises in that part of the nephrogenic cord which lies in direct sequence with, and caudal to, the last mesonephric segment. In the human embryo it is quite small, and on the formation of the ureteric bud lies internal to it; but it rapidly grows around the ureteric bud, and provides it with a cap. When the collecting tubules of the 1st order form, the metanephric cap divides, keeping pace with the tubules, thus providing each set with a cap of excretory tissue. And so the process advances with every formation of a new order of collecting tubules, until at last all 12 orders of tubules are formed, each with their own excretory cap. At this stage, so closely packed together are the branches of this ureteric tree, that the contiguous islands of excretory tissue all coalesce, and the first representation of the formed kidney is now obtained. From the excretory caps are formed Bowman's capsules and the uriniferous tubules.

It is clear, therefore, that union must take place between the terminal collecting tubules and the uriniferous tubules before the function of the kidney can be established. There is apparently a union of some tubules in one of the earliest orders; but the view held by Felix is that the final union occurs much later. However accomplished, this union is a most complicated process, and for this reason slight disturbances of development may give rise to quite marked anomalies.

The account here given is the commonly accepted theory as so ably expounded by Felix; but it is not possible to leave the subject without referring to the work done by O. F. Kampmeier¹², who has brought forward an entirely new conception of the development of the kidney. He suggests that, in the metanephric caps surmounting the collecting tubules of the 1st order, uriniferous tubules are developed and unite with the collecting tubule. These uriniferous tubules then undergo cystic degeneration and disappear. With the formation of collecting tubules of the 2nd order, uriniferous tubules of the 2nd order develop and unite with the collecting tubules. Again there occur cystic degeneration and disappearance. And so the process continues up to the final order of tubules. If Kampmeier's account be true, it must be obvious that there are enormous numbers of tubules which are formed only to undergo cystic degeneration and death, and therefore the possibilities of such degenerated areas remaining instead of disappearing completely are very great. It seems probable that the origin of certain cystic diseases of the kidney must be sought much earlier in their developmental history than has been previously thought. As will be explained later, single large cysts of the kidney are much easier of explanation by Kampmeier's work than they were before.

4. The Wolffian Duct.—The Wolffian duct is the primary excretory duct of the pronephros and mesonephros. Arising originally by the fusion of the pronephric principal tubules, it is joined later by the similar mesonephric tubules. It terminates in the lateral wall of the cloaca, and, as has been explained, gives origin to the ureter bud. During the degeneration of the pronephros and mesonephros, the duct keeps pace with that process. In the male, it is represented by the ducts of the epididymis and the vas deferens; in the female it survives only as the duct of Gartner.

5. The Müllerian Duct.—This duct develops primarily from an invagination of the coelomic mesothelium into the summit of the urogenital fold in the region of the 2nd and 3rd thoracic segments. It is present in embryos of 10 mm. greatest length, and represents the ostium abdominale. From the blind end of this pouch a caudally directed outgrowth takes place, immediately external to the Wolffian duct, i.e., between it and the coelomic mesothelium. That is the commonly accepted view, though Professor Frazer suggests that there are grounds for believing that the Müllerian duct is really derived from the Wolffian duct by a process of gradually advancing separation, a state of affairs well recognized in lower forms. The Müllerian duct disappears practically entirely in the male, but is, of course, the main groundwork of the architecture of the female generative organs.

III. THE DEVELOPMENT OF THE PERITONEUM OF THE POSTERIOR ABDOMINAL WALL.

I now pass to the development of the peritoneum of the posterior abdominal wall, and particular emphasis will be laid upon it, because I believe that in anomalies of its formation there exists one of the causes of retroperitoneal cysts. As far as I can gather from my reading of the literature, this origin has not been touched on before. My attention was first called to this

possibility by a suggestion from Professor Frazer, and this part of my paper has resulted from our many discussions of this subject.

It is the peritoneal relations of the large intestine to which I wish to draw attention, and I cannot make my point clear unless I touch briefly on the return of the intestine from the umbilical sac and the rotation of the intestine, which the former so largely influences.

1. The Return of the Intestine within the Abdominal Cavity.—It will be seen from *Fig. 90* that in a 35-mm. embryo the mass of intestines is still in the umbilical sac, which is shown opened, exposing the contents *in situ*. It will be appreciated that the colon lies in the left part of the sac, and enters the abdomen to the left of the proximal loop; and further, it can readily be seen that the colon and its mesocolon can be considered in two parts, viz.,

the abdominal and umbilical. The abdominal mesocolon stretches from the neck of the sac to the posterior abdominal wall in the mid-line, and therefore acts as a median septum in the upper part of the abdomen. This is a feature of the highest importance.

Frazer and Robbins,^s in their admirably lucid paper on the factors concerned in the rotation of the intestine in man, have developed a reasoned argument to explain the mechanism by which the intestine returns and takes up its eventual adult position. They point out that the return

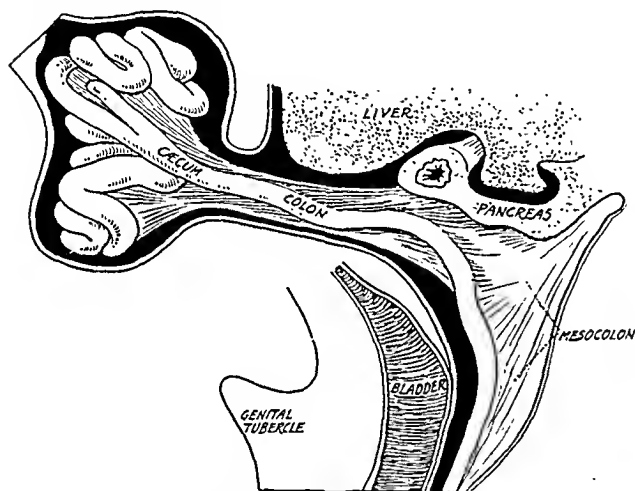


FIG. 90.—Drawing of a section through an embryo of 35 mm. just to the left of the middle line, seen from the left. The umbilical sac is opened and the intestine seen *in situ*. The cæcum and appendix will be seen in the left of the sac, and the returning colon is on the left of the proximal loop. The abdominal colon and its mesocolon are well shown. (From a reconstruction by Frazer and Robbins.)

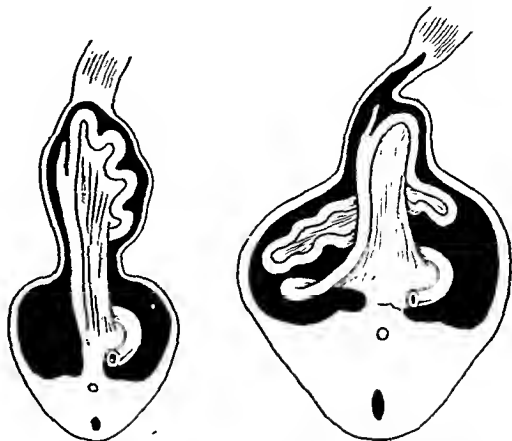
is a rapid—almost instantaneous—process, and is brought about by the changes in relative pressures of the abdominal cavity and amniotic sac. They proceed to show that the return begins with the proximal loop, followed by the next coil, and the next, and so on, until at last only the cæcum remains, and on its return that step in the whole process is complete.

The disposition of the returning loops follows a definite plan, and has far-reaching effects upon the development of the peritoneum of the posterior abdominal wall. If it be recalled that the proximal loop in the neck of the umbilical sac lies to the right of the distal or colic loop (*Fig. 90*), and that the abdominal mesocolon forms a median septum, it follows that the returning loop must necessarily pass to the right of this septum, and will then lie below the right lobe of the liver. As more intestine returns, the mesocolon is displaced dorsally and to the left, and the coils come to lie ventral to it, and

below the cæcum and ascending colon, which are still in the sac. When this part of the gut returns, it will lie above and ventral to the coils of small intestine and below the liver (*Figs. 91 and 92*). It has naturally turned towards the right, thus coming into line with the distal part of the colon. As the coils increase rapidly in length, the cæcum is pressed back until it reaches the dorsal wall, on which it lies, but to which it is not adherent.

2. The Method by which the Colon gains its Adult Position: the Mesocolon.—

The foregoing description has brought the cæcum and the ascending and descending colon into relationship with the posterior abdominal wall, but they have not yet reached their adult position. This is seen in an embryo of 55 mm. (*see Fig. 93*). It remains to describe how this is brought about. *Fig. 94*



Figs. 91, 92.—Diagrams of abdominal cavity and umbilical sac seen on section from above, to illustrate the mechanism of the laying down of the mesocolon on the posterior abdominal wall (*see text*). (*After Frazer and Robbins.*)

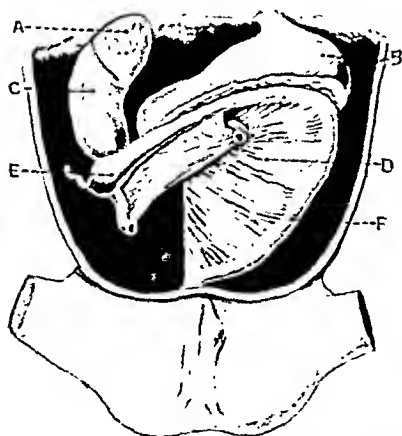


Fig. 93.—Drawing of an embryo of 61 mm, dissected to show the mesocolon. The small intestine has been removed. The cæcum is seen on the posterior abdominal wall, but not adherent, and the descending colon is shown well out towards the flank, but not adherent. It is held up by a glass rod. The mesocolon is well shown, that on the right being derived from the mesentery of the loop, that on the left from the abdominal mesocolon. A, Suprarenal; B, Stomach; C, Kidney; D, Mesocolon; E, Cæcum; F, Descending colon.

explains diagrammatically the extension of the colon. No. 1 represents the position in a 45-mm. embryo, No. 2 that in a 63-mm., No. 3 that in a 125-mm., No. 4 that in a 160-mm. embryo, and No. 5 that in a full-time fœtus. From this it is evident that the whole colon is elongating; the future splenic flexure is travelling

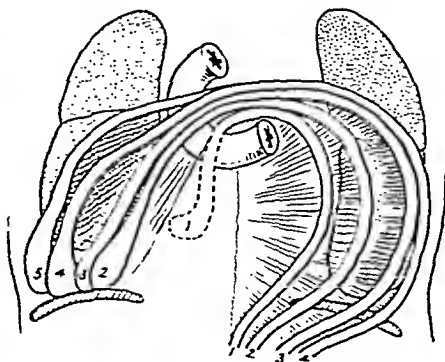


Fig. 94.—A scheme from Frazer and Robbins' paper to illustrate the gradual movement of the colon outwards from the mid-line (*see text for description*).

upwards and to the left. and the hepatic flexure to the right and less markedly upwards because of the liver; with this there occurs an extension in the area of the mesocolon. and it is to the ascending and descending colon that particular attention will now be drawn. When the ascending and descending colon with their mesocolon are swung back upon the posterior abdominal wall, it is evident that three layers of peritoneum must be in contact, viz., the peritoneum of the posterior abdominal wall and the two layers of the mesocolon. It follows that, for the adult arrangement to be produced, two of these layers must disappear. leaving the gut fixed on the abdominal wall. The two layers to go must be the posterior one and the middle one. The contention here raised is that, should these two layers fail to disappear completely, small islands of peritoneum will remain behind the peritoneum, and that these may act as the *Anlage* of a retroperitoneal cyst.

IV. CLASSIFICATION AND DESCRIPTION OF CYSTS OF VARIOUS ORIGINS.

Having briefly outlined certain embryological processes, I now turn to a description of the several varieties of retroperitoneal cysts, and will therefore suggest a classification of them. It may not be exhaustive, and is assuredly open to criticism; but it does, in my opinion, cover the ground, and, moreover, deals with the subject on an embryologico-anatomical basis, which I believe to be the correct one.

- | | | |
|--|---|---|
| A. Cysts of urogenital origin | { | 1. Pronephric
2. Mesonephric
3. Metanephric
4. Müllerian |
| B. Cysts of mesocolic origin | | |
| C. Cysts arising in cell inclusions—Teratomatous cysts | | |
| D. Lymphatic cysts | | |
| E. Traumatic blood cysts | | |
| F. Parasitic cysts | | |
| G. Cysts of developmental origin in
fully-formed organs | { | 1. The kidney
2. The pancreas |

Some of these almost explain themselves, but a short description of them all will be given.

A.—Cysts of Urogenital Origin.

Naked-eye Appearance.—When first exposed and seen *in situ*, they appear as bluish thin-walled cysts and rather flabby, never being tightly distended. When removed they are translucent and lose their bluish tinge. There are no visible vessels in their walls; they have no demonstrable pedicle and no connections—save by areolar tissue—with the surrounding structures. When opened they have a smooth, glistening lining membrane; are single, not multilocular; and contain a clear serous fluid of low specific gravity, in which there is occasionally cholesterol.

Microscopic Appearances.—The wall is thin and consists of a cellular fibrous tissue lined by epithelium, which is usually of a low columnar type, but may be cubical, and rarely is flattened. In one section in my possession the columnar epithelium contains one or two goblet cells, which stain with

muci-carminé. The cells are small, have well-staining nuclei, and a cytoplasm which stains faintly with eosin.

Situation.—From a study of the development of the urogenital system, it is clear that these cysts will occur in an area bounded above by the lateral ligament of the liver, below by the internal inguinal ring, internally by the outer margin of the psoas magnus muscle, and externally by the lateral abdominal wall. A second area lies in the pelvis along the line of the vas deferens in the male and the broad ligament in the female. The majority of the reported cases occur near the kidneys or behind the colon, and near the head or tail of the pancreas.

The question must inevitably arise as to the identification of such conditions, when a retroperitoneal cyst is met with in a patient. Can a cyst be established beyond question to be of urogenital origin? I think not, though their situation and histology are suggestive. The fact remains that there is nothing absolutely conclusive about their histology, and no dogmatic expression of opinion is justified. I hope, however, I may claim that I have demonstrated that there are ample possibilities of remnants of this embryologic system to render such an origin probable; but even if this premise be accepted, it is still difficult to establish from which part of the system any particular cyst has arisen. It can be said, however, that a cyst lying above the plane of the foramen of Winslow is either pronephric or mesonephric in origin, those below that level either mesonephric or metanephric. And when cysts are found near to an unusually small kidney, then there are strong grounds for assuming that the cyst is of metanephric origin. My first case and that reported by Frazier⁹ are examples of this type.

On the subject of cysts of the female pelvis, very little doubt need be entertained. Those occurring in or near the broad ligament are well recognized, and have been given various names by gynæcologists. They had much better be designated broad ligament Wolfian cysts, for they are undoubtedly of mesonephric origin.

Fimbrial cysts are, of course, Müllerian.

Case 1 has already been described. *Case 2* occurred in the practice of my father's partner, Dr. Cowper, of Shanklin, Isle of Wight, to whom I am indebted for the details of the case and the microscopic preparations. As will be seen, the record is not quite complete, for I have had to rely upon a description of the case.

Case 2.—A girl of 15 years had a sudden transient symptomless hæmaturia lasting thirty-six hours, succeeded three months later by an exactly similar attack. Dr. Cowper was then asked to see her, and a swelling was found in the left side of the abdomen, rather high up and partly under cover of the left costal margin. The swelling was soft and apparently cystic, and an exploratory laparotomy was decided upon. A large cyst was found pushing the stomach and transverse colon in front of it, and coming apparently from the back of the abdomen. Considerable difficulty was experienced, but it was traced back to the neighbourhood of the left kidney. Attached to its deepest part were three tubules, each about the size of a normal vas deferens. The cyst and tubules were removed, but unfortunately it was not possible to define the exact connections of these tubules. The wound was closed, a rubber tissue drain being inserted. The patient stood the operation well, and all went well until, on the third day, there was a clear discharge from the wound. The next day this had become more copious, and was soon recognized as urine.

This urinary fistula continued for some weeks, until a left-sided nephrectomy was performed. The wound then healed without difficulty.

The cyst itself was typical in its naked-eye appearance, but the wall contained a thin layer of unstriated muscle fibres. The contents were clear fluid, but were not examined chemically. One tubule was sectioned, and showed the same structure as the cyst wall. Both had a lining of very rudimentary epithelium, which was only present in small areas.

The kidney was described as small, and infantile in type, being markedly lobulated, but no obvious lesion could be found in it. That it had some connection with the cyst seems indisputable, but the exact nature of that connection cannot now be stated. It seems probable that this was some anomaly in development of the excretory system, but beyond that it is not possible to go.

Cases similar to *Case 1* are reported by Ashhurst,² Lapointe,¹³ Frazier,⁹ Elder,⁵ Elter,⁶ and others.

Cysts of urogenital origin occur in both sexes, but more commonly in women. They are seen between the ages of 10 and 50, but the decade 15-25 provides most of the cases. The left side of the abdomen is more frequently affected than the right.

B. Cysts of Mesocolic Origin.—In general appearance these will resemble the urogenital cysts described above, and are composed of a fibrous wall lined by a delicate flattened epithelium. They are found only in the area between the ascending and descending colon and below the transverse mesocolon. When they are removed they show little to distinguish them, but while still *in situ* one anatomical relationship will decide the question. Mesocolic cysts will lie anterior to the spermatic or ovarian vessels, while urogenital ones will be posterior to them. This is a point worth investigating during an operation on these conditions.

Case 3.—Post-mortem case, male, age 64, death due to heart failure after a preliminary suprapubic cystostomy for enlarged prostate. A small cyst was found lying behind the peritoneum and in close contact with it, to the inner side of the descending colon, and near the spermatic vessels. It consisted of a thin fibrous wall, lined in some places only by a fine, flattened epithelium. (Many of these cysts are reported as having no lining membrane at all, but traces of one can usually be found after prolonged search.) This cyst is either mesocolic or lymphatic in origin.

C. Cysts arising in Cell Inclusions.—The teratomatous cyst—commonly known as the dermoid cyst—is found not infrequently in the retroperitoneal tissues. Two of my cases were of this nature, and a third I owe to the courtesy of Dr. Robert Knox and Dr. Harrison Orton. Their structure is well known, being composed of a fairly thick cyst wall, and containing usually an intracystic prominence upon which may be found teeth and hair. The cyst is usually filled with sebaceous material and hairs.

Case 4.—Woman, age 62, had vague indefinite pains in the lower part of the abdomen and in the back for several weeks. She had a bad attack of diarrhoea fourteen days before admission. On examination, a rounded swelling was felt in the neighbourhood of the caecum. Typical 'dermoid' cyst removed from behind the caecum.

Case 5.—Age 59, with a very similar history to the above. In this case a cyst was found behind the peritoneum near the hepatic flexure. It contained sebaceous material and hairs, and was lined by squamous epithelium.

Case 6.—(Dr. Robert Knox's case). Discovered unsuspected in the course of a barium meal examination. It was found to be attached to the anterior aspect of the head of the pancreas.

The origin of the teratomata has been the subject of many theories and much criticism. No useful purpose would be served by a discussion of such theories here; but retroperitoneal dermoids are among the rarer teratomata, occurring as they do outside the genital system, and it is these extra-genital cases that have discredited several theories that might explain ovarian or testicular tumours, but which could not account for the remainder. There is one theory that has not obtained that prominence to which it is justly entitled, viz., *Felix's strayed genital cell theory*. In the past most embryologists have accepted the view that the genital cells arise in the coelomic mesothelium of the genital ridge of the urogenital fold; but the modern view suggests that the primary genital cells are of much earlier origin than this, being derived from the segmentation cells. *Fig. 95* shows two such primary genital cells in the region of the cloaca in an embryo of 2.6 mm. with 13-14 pairs of segments, and *Fig. 96* shows one in the root of the mesentery in an embryo of 4.7 mm. with 33 pairs of segments. It follows that, in order to reach the *Anlagen* of the genital glands, these

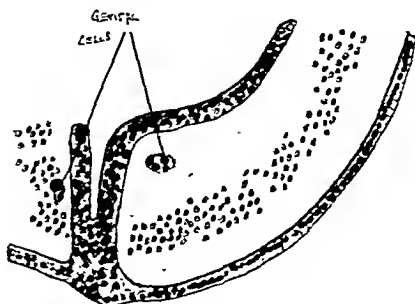


FIG. 95.—The cloacal region of an embryo of 2.5 mm. greatest length. Two multinucleate genital cells are seen near the cloacal membrane. (After Felix.)

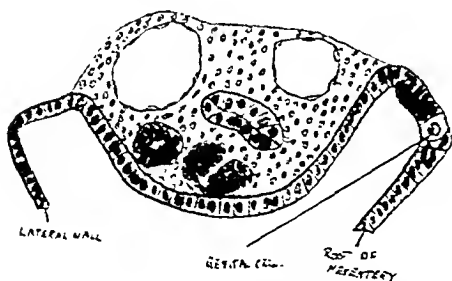


FIG. 96.—Section through the 11th primitive segment of an embryo of 4.7 mm. in length. It passes through the urogenital fold, and shows a primary genital cell in the root of the intestine. (After Felix.)

cells have some distance to travel. It is doubtful if they all reach their goal, and the possibility of some 'strayed' genital cells must be admitted. These cells are totipotent cells, and therefore are possible sources of teratomata. The retroperitoneal cases are all found somewhere near the root of the mesentery, and that would appear suggestive, for the root of the mesentery is the commonest place for these genital cells to be found in very young embryos.

D. Lymphatic Cysts.—These fall into two classes: those formed in the lymphatics returning from the intestine, and those arising in the lymphatic field behind the peritoneum and not connected with the intestine. The first group are known as chylous cysts, and have been fully dealt with by many observers. The second class occur as single cysts of varying size, and are exactly analogous in their origin to the single cystic lymphangioma seen in

the neck. Hadley¹¹ believes them to be due to anomalies in development of the primitive lymph sacs of the abdominal cavity. Gaudier and Gorse¹⁰ report a case of a very large lymphatic cyst in a boy, age 4, which occupied the iliac fossa and spread through the inguinal canal into the serotum. Small multiple lymphatic cysts are sometimes seen, particularly in the pelvis, and my colleague, Mr. Aleck Bourne, tells me that he has frequently seen them in the course of gynæcological operations, and that he is convinced of their lymphatic origin.

E. Traumatic Blood Cysts.—Chardon³ records a case of a girl, age 14, who had fallen and injured her right side two years previously. Nothing serious was noted at the time, but when first seen by him she was found to have a cystic swelling in the right side of the abdomen. At operation a typical blood cyst was found in the retroperitoneal tissues behind the ascending colon. Such cysts are due to a hæmatoma resulting from an injury. These cases will usually be brought to operation as an emergency; but should they not be large enough to cause sufficiently acute symptoms, the development of a blood cyst is a well-recognized result.

F. Parasitic Cysts.—The hydatid cyst stage of the *Tænia echinococcus* is not infrequently seen in the retroperitoneal tissues. It may reach such a situation either by the blood stream, by transcælotomic implantation after the rupture of a cyst in the liver, for example, or by penetrating the intestinal wall at that situation. There is a beautiful specimen in the Royal College of Surgeons Museum in the female pelvis, and another in the Museum of St. Mary's Hospital in the male pelvis. The latter is a good example of the curious symptoms for which these retroperitoneal cysts may be responsible. It was behind the prostate and bladder, and had become impacted in the pelvis. As a result it had pushed the prostate forward, kinking the urethra as it passed through the triangular ligament, and caused chronic urinary obstruction.

G. Cysts of the Pancreas and Kidneys.—In my introduction to this paper I emphasized that the term retroperitoneal cysts should be applied only to those cysts lying in the fatty tissue behind the peritoneum, attached to their surroundings by areolar tissue only. I do not propose, therefore, to deal at length with cysts of the pancreas and kidneys; but these few remarks will not come amiss, I think, in this place. With regard to pancreatic cysts, Primrose¹⁴ in 1922 pointed out that the description and the nomenclature of these cysts in and around the pancreas was most confused and unsatisfactory. When true cysts of the pancreas are mixed up with 'pseudo-cysts' and parapancreatic cysts, the ordinary reader is entirely misled. Again, Donoghue⁴ in 1906, in reviewing the whole ground, analysed twenty reported cases of pancreatic cysts, and could find no evidence that any one of them was really pancreatic in origin. The neighbourhood of the pancreas is one which is favourable for the location of developmental cysts, and I submit that no cyst should be called pancreatic unless it contains pancreatic tissue in its walls or in its pedicle.

With regard to the kidney, two cystic conditions found therein are of developmental origin. The congenital polycystic kidney is well known, and

needs no description. The earlier remarks upon the development of the metanephros will have made clear the two possible methods of its origin. The single cyst of the kidney is, however, quite a different proposition. The commonly accepted theory of the union of the uriniferous tubules with the later orders of collecting tubules could never explain the existence of a large single cyst which had replaced one quarter or more of the kidney; but Kampmeier's theory makes the origin of such a cyst quite clear, for it is easy to understand how a cystic dilatation of one of the second order of collecting tubules could bring about a single cyst with lack of development of that part of the kidney.

V. DIAGNOSIS.

From the foregoing descriptions it will be readily appreciated that the diagnosis is often extremely difficult, and, with the exception of the traumatic blood cysts and the parasitic cysts, there will be little in the history to help. It is, in fact, the very vagueness of the story, the indefiniteness of the signs, and the absence of symptoms typical of other conditions, e.g., the hydro-nephrosis, that should raise the suspicion of a retroperitoneal cyst. In *Case 1* vague symptoms pointed to two systems, the intestinal and the renal, but neither could be really suspected with any confidence. In those cysts which lie in the loin, a pyelogram will be undertaken as a routine, and in this investigation we have a small hope of a diagnosis. Should the photograph show an unusually small pelvis with only two calices, and should there be a cystic and movable swelling in the loin, then I suggest that the diagnosis may be made with some degree of confidence.

Pelvic cysts can be much more readily diagnosed by a thorough bimanual examination, but in the majority of cases the diagnosis will probably be that of an ovarian cyst.

VI. TREATMENT.

These cysts should be removed, access being gained by the most convenient route, through the loin or through the anterior abdominal wall. The loin approach will in many cases give the best exposure, but cysts near the pancreas will demand a laparotomy. The developmental cysts will shell out with the greatest ease. The only one to give trouble will be the parasitic cyst, especially if it is infected. It will rarely be necessary to marsupialize any of them, and for this reason the cysts near the pancreas should be carefully investigated, for all those not truly pancreatic will shell out, and a marsupialized sac will thus be avoided in certain cases.

CONCLUSIONS AND SUMMARY.

I hope I may claim to have presented an accurate classification and a detailed description of these cysts, and a reasonable explanation of their origin. One entirely new possibility has been suggested and supported on embryological grounds. It has been my aim to show how an intimate knowledge of embryology may make clear certain obscure etiological problems. If

it serves to stimulate a closer correlation between the work of the embryologist and the pathologist I shall be satisfied. This has been the principle which has inspired this paper throughout.

My thanks are due to Professor J. E. S. Frazer for his helpful criticism, for permission to use some of his diagrams, and for showing me much of his embryological material. I am also indebted to Mr. W. H. Clayton-Greene, Mr. D. C. L. Fitzwilliams, and Dr. Cowper, for permission to publish cases. To Dr. Robert Knox I owe one of my cases with his X-ray photographs, and to him I offer my sincere thanks. Dr. E. H. Kettle I have to thank for the facilities he has always given me for working in his laboratory, and to him, to Mr. Clayton-Greene, and to Professor Charles A. Pannett I am increasingly indebted for their encouragement and helpful criticism.

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SOME ACTIONS OF RADIATIONS ON LIVING TISSUES.

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(Being the Arris and Gale Lecture delivered at the Royal College of Surgeons of England on February 18, 1924.)

THE earliest observations upon the action of X rays on the tissues were made upon X-ray workers who were found to develop a peculiar form of dermatitis as a result of continued exposure to the rays. The phenomena attending X-ray dermatitis are too well known to need recapitulation here; but *Figs. 97 and 98* may be of interest as showing the development of a malignant neoplasm as a sequel to continued exposure after the patient had received an X-ray burn.



FIG. 97.—This shows a neoplastic ulcer on the finger of an X-ray worker, resulting from prolonged exposure to the rays.

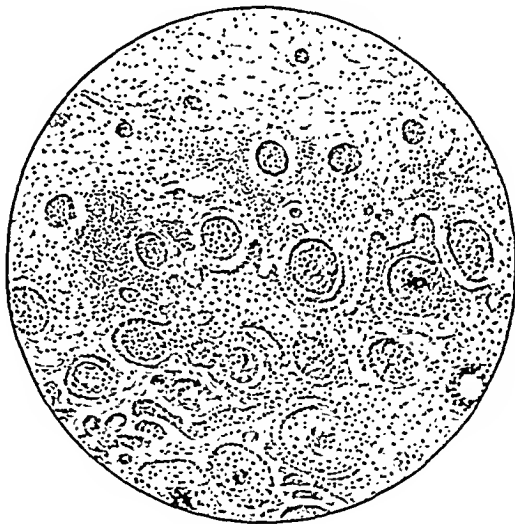


FIG. 98.—Microscopic section of the margin of the ulcer depicted in Fig. 97. It shows hyperplasia of the inter-papillary processes and proliferation of the prickle-cell layer. There is a definite round-celled infiltration and some fibrosis.

That radium salts could produce effects upon the skin similar to those caused by exposure to X rays was noted as early as 1900, while in the following year Becquerel accidentally demonstrated the effect on his own person by carrying an insufficiently protected tube of radium bromide in his waistcoat pocket. The glass tube, which measured 15×3 mm., was wrapped in paper, enclosed in a little cardboard box, and deposited in M. Becquerel's pocket, where it remained for some hours. A week later an area of redness measuring 6×4 cm. made its appearance upon the abdominal wall. The inflammation

progressed, eleven days later the skin disappeared, and an ulcerated surface remained which did not completely heal for a month.

A large amount of experimental work upon animals has been carried out in connection with the action of radium rays upon the skin. The animals employed included pigs, guinea-pigs, and mice, while the amount of radium salt varied from 6 mgrm. of the sulphate to 130 mgrm. of radium-barium bromide. The radium capsules were covered with mica or thin aluminium, and in one case a 'varnish' applicator was used. In all cases there was a latent period between exposure to the rays and the appearance of any visible reaction. As an example of this experimental work we may briefly summarize some researches of Halkin upon the skin of young pigs.¹

The radium capsule, which contained 130 mgrm. of radium-barium bromide, was closed by an aluminium covering 1 mm. in thickness. This was placed in immediate contact with the skin, secured with adhesive plaster, and allowed to remain for two hours. On the eighth day after exposure, the first visible evidence of reaction was noted as a livid spot disappearing under pressure. The maximum change was seen between the twentieth and the twenty-fourth days. About this time the surface of the irradiated area had a bluish livid tint, with areas of yellow pigmentation and patches of desquamated epidermis. In the centre of the area the inflammatory changes were more marked, and a small dry scab covered an ulcerated surface. The changes subsequently became more definitely reparative in character, and all that was noticeable on the thirty-eighth day was a slightly pigmented diffuse mark with some desquamation.

Another series of pigs was exposed to radium in exactly the same manner and with the same capsule of radium-barium bromide. In this case, however, the exposure was only for one hour. The reaction was longer in appearing—fifteen days—was of less intensity, and disappeared sooner than in the two-hour series.

Radium Dermatitis (*Figs. 99, 100, 101*).—Radium dermatitis, being much less common than the condition produced by X rays, has received small attention in this country, although the Americans have considered the matter in some detail. It is only within recent years that the ultra-violet and chemical rays of the spectrum have been appreciated as the more important agents in the production of many common clinical conditions. Previously erythema solare and the common freckle were attributed to the heat of the sun. It was also noticed that certain cases of lupus erythematosus suggested that light was the determining factor in the site of the eruption. Hydroa aestivale belongs to the same group of diseases. The production of pigmentation by means of the carbon arc in the latest type of treatment in lupus vulgaris is merely another instance of the importance of the rays at the violet end of the spectrum.

Clinically the pictures produced by excessive exposure to the X rays and to radium are indistinguishable. This is to be expected when it is remembered that the γ rays of radium are in juxtaposition in the spectrum with, and overlap, the X rays. The important fact is demonstrated by the following case:—

Mr. —, age 65, has been handling radium salts continuously since 1904. During 1913 he noticed for the first time a little roughness of the hands; at

the same time he experienced a tingling sensation in the fingers. The war saw a very considerable increase in the amount of material that passed through his hands, with the result that in 1916 his hands became discolored and his nails began to fissure and were very friable. The first appearance of warts was delayed until 1920, since when they have gradually increased in number.

To-day the skin of both hands is atrophic, thin, dry, and wrinkled; there are scattered about numerous small patches of lightish-brown pigmentation. Dilated capillaries form a thin network over the surface. There are present numerous small hyperkeratoses, the largest



FIG. 99.—Photograph of both hands, showing atrophic pigmented skin with telangiectases and warts. Striation and fissuring of the nails is well marked.

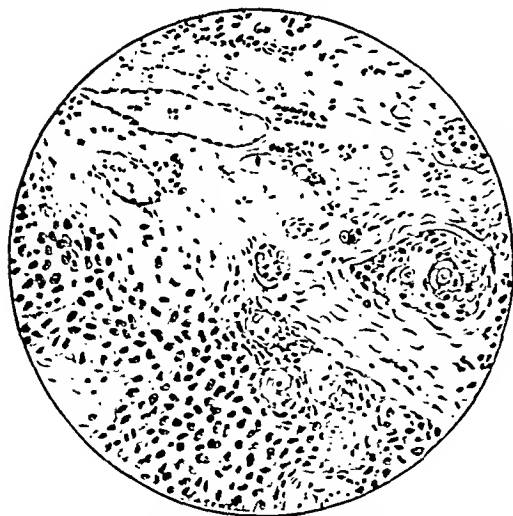


FIG. 100.—High-power view of the centre of the wart. There is extensive epithelial proliferation, with degeneration and vacuolation of the cells. Early invasion of the corium by the epithelial cells is well seen.

being on the third digit of the left hand, and its size less than that of a threepenny piece. No ulcers are anywhere present. The nails are all thinned, striated, fissured, and brittle. The nail bed at its free edge is markedly thickened. Great stress has been laid on this phenomenon as being characteristic of radium dermatitis, and indeed it is the only means of distinction between it and X-ray dermatitis.

For histological purposes the largest wart was excised under local anaesthesia. The wound healed well. The picture presented under the microscope is that of chronic inflammation, together with very early squamous-cell carcinoma. The stratum corneum is markedly thickened, but most of its cells have been

lost over the centre of the wart. The stratum granulosum is not very distinct. The interpapillary processes are prolonged downwards to a marked

extent, as well as showing some branching. There are numerous cell nests, and a few squamous cells are very definitely seen to be invading the corium. The condition is one of early, but yet unmistakable, malignancy. The cells in the centre of the processes are in places definitely degenerate; many others are swollen and show apparent vacuolation around the nuclei; whether this is true vacuolation or œdema of the cells is not clear. Among the prickle cells a few mitotic figures were observed. Even where karyokinesis was not evident, the nuclei varied greatly in size, the larger of them presenting a very active appearance.

The superficial layers of the corium are œdematous, whilst the deeper layers show a definite increase in the white fibrous tissue. In places a slight secondary leucocytic infiltration is present. But far and away the most important feature is the destruction of the elastic tissue; in many places it is

absent, whilst when present it is completely disrupted and is seen as short twisted fibrils. This striking result of excessive radiations will be better appreciated when it is realized that the accompanying illustration (*Fig. 101*) portrays the field in which most elastic tissue was observed.

Thus, it is seen that radium and X-ray dermatitis are exactly similar, and indistinguishable both clinically and histologically, except for the subungual hyperkeratosis seen in the former condition.

The process of healing in cases of damage caused to the skin by exposure to radium manifestly depends upon the amount of damage which has been produced. In some cases

only the hair follicles and sweat glands are permanently destroyed; in more extreme cases attended with ulceration, the ulcer heals in the ordinary manner with the formation of fibrous tissue.

The Action of the X Rays on the Developing Chick Embryo.—The first experiments upon the effects of exposure of chick embryos to the X rays were those of Gilman and Bactjer² in 1904. Here the observers recorded an initial acceleration of development, followed by retardation and the production of abnormal forms. Bordier and Galimard³ in 1905 obtained inhibition of development as a result of exposure, as also did Gaskell in 1911. In 1922 a series of experiments by Drs. H. A. Colwell,⁴ R. J. Gladstone, and myself were carried out at King's College Hospital. The object of these experiments was to ascertain the action of rays of different degrees of 'hardness' upon developing tissues. The chick embryo was selected as the subject of experiment, and

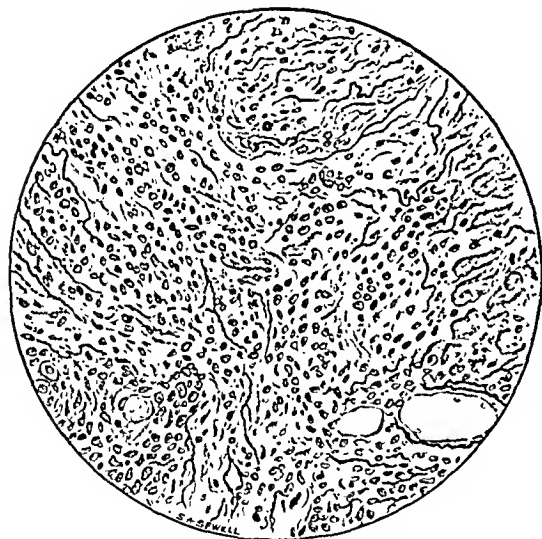


FIG. 101.—A section stained to demonstrate the destruction of the elastic tissue in the corium.

a series of 36 fertilized eggs were subjected daily to irradiation for a period of eight days. These were divided into four series, which received one pastille dose, $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{1}{4}$ of a pastille dose respectively daily. The same series of screens were used in all the experiments; they were aluminium screens of $\frac{1}{2}$ mm., 1 mm., and 2 mm. in thickness.

Our conclusions were that in chick embryos irradiated immediately before incubation and then subjected daily to irradiations for several days, the following results were obtained: The action of the rays was in all cases inhibitory, irradiated embryos being invariably smaller than controls. Within the limit of radiation investigated, the effects seem rather to depend upon the total amount of radiation reaching the embryo than upon its quality or 'hardness'. In the series which received a full pastille dose, 6 out of 9 specimens examined showed no sign of development at all. As regards the susceptibility of individual tissues and structures to these conditions, this was found to be most marked in the surface ectoderm, the central nervous system, and the eye.

Further experiments have yielded results which indicate that exposure of embryos which have been allowed to incubate normally for a period of ninety hours, and which have then been exposed to X rays for three successive days, produces in some cases a certain degree of stimulation as indicated by a slight increase in size. These investigations are still in progress.

The Effects of X Rays on the Skin of the Frog Tadpole.—These experiments were carried out at King's College Hospital, and their object was to ascertain the effects of prolonged irradiation upon the rapidly-growing tissue at different periods after exposure, and also to see in what manner these effects are modified by irradiation in the presence of colloidal silver. In the latter case, the effects produced are due not only to the action of the primary beam, but also to the soft secondary radiations given off from the minute colloidal particles of the metal.

For the purpose of experiment, frog tadpoles were used; these were exposed to the unscreened radiations from a Coolidge tube working at 2 ma. with a 7-in. spark-gap. In most of the experiments the animals were exposed in $1\frac{1}{2}$ in. of water in open glass dishes, the distance of the anticathode of the tube being $6\frac{1}{2}$ in. from the surface of the water. As the tadpoles tended to lie at the bottom of the vessel, it is clear that there must have been a certain amount of 'screening' from the superjacent layer of water. In order to diminish this factor, other specimens were exposed for different periods in about $\frac{1}{2}$ in. of water, which was changed from time to time during the exposure, so as to eliminate as far as possible any heating effects. The distance of the anticathode from the surface of the water was, as before, $6\frac{1}{2}$ in. In a further series a small amount (0.04 per cent) of protargol was added to the water containing the tadpoles; in these cases the irradiation was carried out in dishes containing $1\frac{1}{2}$ in. of protargol mixture, the distance of the anticathode being again $6\frac{1}{2}$ in. Seven series of experiments were carried out, and histological examination of the skin was performed.

In the normal tadpole skin the epidermis consists of only two layers of cells (Fig. 102). Of these, the superficial layer is formed of somewhat flattened cells with more or less oval nuclei, while in the deep layer the cells tend to

become polygonal in outline and the nuclei roughly correspond to the shape of the cell. The pigment cells lie in the corium in close apposition to the subjacent muscle bundles.

The conclusions drawn from these experiments were as follows: In the specimens irradiated immediately after death, very slight changes were noted. Prolonged irradiation within certain limits causes the characteristic changes to appear more quickly; for instance, a specimen killed immediately after

one and a half hours' irradiation showed only some increase in the size of the nuclei of the superficial epidermal layer, together with evidences of increased activity; while specimens which had received two hours' irradiation, and which were killed immediately afterwards, showed slight but definite hyperplasia. Irradiation in the

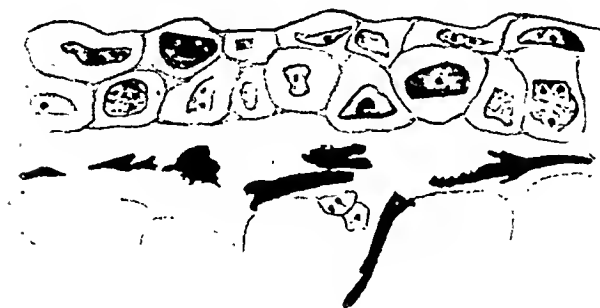


FIG. 102.—Section of normal skin of frog tadpole.

presence of colloidal silver causes much more rapid and profound changes. These were of a markedly stimulative character, within the limits of time after irradiation in which observations were made. (Figs. 103, 104.)

A further series of experiments is being carried out on the skin of frogs and other cold-blooded animals, and will be published in due course.

Action on Blood-vessels.—The endothelial lining of the smaller blood-vessels is remarkably sensitive to radiations, the cells becoming swollen, vacuolated, and degenerated, with a tendency to irregular proliferation into the lumen of the vessel. At the same time the vessel wall is infiltrated by leucocytes. From these facts it is clear that exposure to radiations tends to destruction of the blood-vessels, and this explains the clinical use of radium in the treatment of nævi. It shows, moreover, the necessity for care in the clinical use of radium in situations where hæmorrhage cannot be readily controlled and there is reason to suspect the presence of pre-existing degenerative vascular changes.

Exposure to X rays similarly gives rise to degenerative changes in the blood-vessels, and indeed so marked are the changes set up by X rays and radium that they have been regarded as the immediate cause of X-ray and radium burns. Undoubtedly, interference of any kind with the vascular supply to a part must have a greater or less effect in determining the course of any local pathological processes. Vascular changes, however, cannot account for the whole of the phenomenon, and in any case do not afford an explanation of how the vascular endothelium itself comes to be injured.

The changes in the lining cells of the blood-vessels do not occur immediately after exposure to the radiations, but a more or less variable latent period elapses between exposure and its obvious results.

Effects on the Blood.—The action of X rays and the γ rays of radium upon the blood has recently attracted a good deal of attention, as it has

been held responsible for cases of severe—and in some instances fatal—anæmia. These occurred among X-ray and radium workers who carried out their duties under conditions of insufficient protection. With the recent developments of prolonged and intensive X-ray therapy the matter is also obviously



FIG. 103.—Section across tail of tadpole which died 27½ hours after irradiation. Showing hyperplasia and invasion of cerium by epithelial cells.



FIG. 104.—Section across tail of tadpole killed 48 hours after irradiation in protargol. General hyperplasia of epithelium is seen.

one of considerable importance, and accurate blood-counts are now a matter of routine procedure in the case both of workers and of patients undergoing treatment. A very large amount of work has been done upon the subject, which it is impossible to discuss here in full detail. The outstanding features

of exposure to the radiations are a marked diminution in the number of lymphocytes, together with a reduction in the number of red cells. In the earliest stages there may be a transient increase in both types of cell. Lymphocytes seem to be especially sensitive to radiations, exposures for quite short periods causing a marked diminution in the lymphocyte count. Polymorphonuclear leucocytes are also diminished in number, but not to the same extent as the lymphocytes. Blood-platelets as a consequence of exposure show a rapid diminution in numbers, followed by a rapid recovery.

As regards the action of radiations upon blood *in vitro*, exposure to radium emanation produces hæmolysis, with the formation of methæmoglobin, the α particles taking by far the largest part in the production of the phenomenon, and they are also destructive to the opsonic power of the serum and to the hæmolytic complement. Exposure to X rays has not been found to interfere with the action of immune sera, nor with that of the hæmolytic complement. Further experimental work, however, is necessary upon the question of the action of radiations upon immune sera. Hæmolytic complement is notoriously unstable, but exposure of samples for two hours to X rays of moderate hardness was found to be without effect.

Action on the Intestines.—The mucous membrane of the intestine is extremely sensitive both to X rays and to the γ radiations from radium, a fact which must be borne in mind from the point of view of the protection of the X-ray worker and of the patient when radiations are being used for the treatment of abdominal conditions. The earliest effect of exposure is the production of an inflammatory condition associated with diarrhœa and, if the dose of rays has been sufficient, the passage of blood-stained mucus. More prolonged exposures lead to destruction of the lining epithelium of the gut, with shrivelling and atrophy of the subjacent tissue. The occurrence of diarrhœa, then, in the case of persons working with X rays or in that of patients undergoing X-ray treatment in the abdominal region, should always receive attention when there is no other obvious cause for its occurrence.

CLINICAL INVESTIGATIONS.

The clinical material investigated was as follows: (1) *Carcinoma of the breast*, 25 cases; (2) *Rodent ulcer*, 58; (3) *Lymphosarcoma of neck*, 4; (4) *Sarcoma of femur*, 3; (5) *Carcinoma of lip*, 2; (6) *Carcinoma of thyroid*, 1; (7) *Carcinoma of mouth*, 4; (8) *Carcinoma of cervix uteri*, 3.

1. Carcinoma of the Breast.—The cases of carcinoma of the breast had had a complete amputation of the breast performed previously to the X-ray or radium treatment. No pre-operation treatment by irradiation was given, for the following reasons: the skin under such conditions heals badly, the risk of sepsis is increased, and the tissues are more congested, so that oozing is often considerable. Of the 25 cases, 15 received post-operative irradiation from X rays, this treatment only being given when there were signs of recurrence. All these cases died, the average period being three years from date of operation. Ten cases received immediate radium irradiation at the time of the operation, and subsequent X-ray treatment. Of these, 2 died from secondary manifestations after five and six years respectively. The remaining 8 are alive after an average of six years, although 3 have signs of internal metastases.

The outstanding fact in this series is that no local recurrences have been observed in the cases treated with radium at the time of the operation.

Case 6 in this series was of interest in showing the effect of radiations on the blood-count.

Case 6.—Mrs. S. B., age 50, came under observation in May, 1921, with a lump in the upper and outer quadrant of the left breast. Patient stated she had noticed a lump for six months. The tumour was not attached to the skin or deep fascia. There were no palpable glands in the axilla. Radical removal of the breast, together with both pectoral muscles, axillary fat, and glands, was performed at the end of May. The wound healed well. The tumour was a spheroidal-celled carcinoma. When the patient was seen again early in September, 1921, there was a small recurrent nodule in the scar. It was decided to give X-ray treatment and to see what effect this had on the blood-count. A full pastille dose was given to four areas of the thorax through a 4-mm. aluminium filter, and a blood-count was taken again immediately after the X-ray treatment, and again on the two following days.

BLOOD-COUNT BEFORE X-RAY TREATMENT		AFTER X-RAY TREATMENT			
	Sept. 20, 1921	Sept. 20, 1921	Sept. 21, 1921	Sept. 22, 1921	
Red blood-corpuscles.					
per c.mm.	6,148,000	6,000,100	6,100,000	6,384,000	
Total leucocytes,					
per c.mm.	12,000	12,800	13,000	10,600	
Polynuclears ..	68.0 per cent	72.4 per cent	74.4 per cent	70.3 per cent	
Lymphocytes ..	29.4 ..	26.0 ..	24.0 ..	27.6 ..	
Eosinophils ..	7.0 ..	1.6 ..	1.6 ..	2.1 ..	

A few days afterwards, on Sept. 27, a blood-count was taken and the patient submitted to a pseudo-dose of X rays, the blood-count was taken, the patient was given a full pastille dose to four areas on the left side of the thorax, and the count taken again. This was tried in order to see if the pseudo X rays had any effects on the leucocyte-count. It was found that no difference could be made out. The results were as follows:—

BLOOD-COUNT BEFORE PSEUDO X RAYS		AFTER SAME		AFTER X RAYS	
Red blood-corpuscles ..	5,936,000				
Total leucocytes ..	10,400	10,800		9,000	
Polynuclears ..	74.2 per cent	72.6 per cent		73.3 per cent	
Lymphocytes ..	24.7 ..	24.8 ..		26.3 ..	
Eosinophils ..	21.0 ..	2.4 ..		0.5 ..	

Again, on Oct. 5, 1921, a blood-count was performed before and after the same dose of X rays.

BEFORE X RAYS		AFTER X RAYS	
Red blood-corpuscles ..	4,368,000		
Total leucocytes ..	11,500	10,400	
Lymphocytes ..	27.6 per cent	32.7 per cent	
Basophils ..	0.1 ..	0.3 ..	
Eosinophils ..	1.2 ..	1.2 ..	
Polynuclears ..	71.1 ..	65.8 ..	

At first X-ray treatment seems to have a stimulating effect on the production of leucocytes, and later on its action is inhibitory, so that it is necessary when giving deep X-ray therapy to have a blood examination performed from time to time.

In this case radium treatment was substituted in November, 1921, 60 mgrm. filtered through 2 mm. of lead being applied to the recurrent nodule for four hours each month. The nodule disappeared, but the patient gradually became more breathless in February, 1922, and died in the following May. A skiagram demonstrated large secondary deposits in the thorax. No post-mortem examination was permitted.

2. Rodent Ulcer.—In the treatment of the earlier cases of rodent ulcer, large doses of radium were used in combination with lead filters; very poor results were obtained. The ulcer increased in size, and in several cases excision was eventually performed. One of the most hopeful methods of application of radium appears to be that of repeated small doses daily for a period of seven to fourteen days, followed by a week or fortnight's rest, when the course of treatment is resumed. In these cases no screen was used beyond the platinum containers in which the radium was placed, which was separated



FIG. 105.—Photograph showing position of rodent ulcer before radium treatment.



FIG. 106.—Photograph showing condition of rodent ulcer after fifteen months' radium treatment.

from the diseased surface merely by a layer of guttapercha or lint, thereby allowing the passage not only of the softer γ radiations, but also some of the hard β rays which appear to play an important part in the process of treatment.

Case 2 in this series is of interest because histological examination was carried out before and after radium treatment. It may be laid down as a general rule that if a rodent ulcer does not respond to radium or X-ray treatment after three months, it should be excised.

Case 2 (Figs. 105-109).—William P., age 66, first came under observation in September, 1920, complaining of a small ulcer the size of a shilling situated in the

right temporal region 2 in. behind and 3 in. above the external canthus (*Fig. 105*). This ulcer began in October, 1919, as a small pimple which slowly grew larger and broke down and was treated by different kinds of ointments which had no effect. A small piece of the edge of the ulcer was removed, and microscopically it proved to be a rodent ulcer (*Fig. 108*). Radium treatment was tried for fourteen months;



FIG. 107.—Photograph one month after excision and skin-grafting.

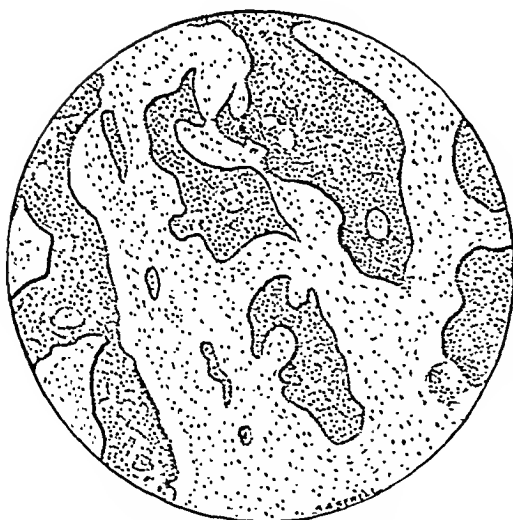


FIG. 108.—Section of edge of rodent ulcer excised before treatment.



FIG. 109.—Section taken after excision of rodent ulcer, showing marked fibrosis as the only change consequent on radium treatment.

60 mgrm. of radium filtered through 2 mm. of platinum were applied to the ulcer every two weeks until December, 1921. As no improvement took place, the ulcer was completely excised and the bare area skin-grafted. The microscopical appearance of the ulcer after removal revealed the fact that a very definite fibrosis had taken place (*Fig. 109*).

3. **Lymphosarcoma of Neck.**—The four cases of lymphosarcoma all responded well locally to radium irradiation at first, but death occurred in each case owing to widely disseminated and deeply-seated metastases.

Case 2 (Figs. 110–114).—George W., age 66, came under observation in April, 1922, with a large tumour on the left side of his neck (*Fig. 110*). He first noticed a small lump behind his ear in February, 1922, which soon spread to the whole of



FIG. 110.—Photograph of patient with lymphosarcoma before radium treatment.



FIG. 111.—Photograph showing condition of patient five days after the insertion of 200 mgrm. of radium.



FIG. 112.—Photograph of same patient taken two months after *Fig. 111*.

the side of his neck. At the beginning of May, 1922, the swelling was so large that it compressed the trachea, and a tracheotomy had to be performed on May 10. Radium, 200 mgrm., filtered through 2 mm. of platinum, was inserted deeply into the tumour for eighteen hours on May 15. A small portion of the growth was removed for microscopical examination; the tumour proved to be a lymphosarcoma (*Fig. 113*). The tumour commenced to disappear on May 17, and had

become very much smaller by the 18th, and on May 20 a photograph was taken (*Fig. 111*); the tumour had almost completely disappeared. However, in July growth became palpable on the left side of the neck again, and 100 mgrm. of radium were inserted into the neck for twelve hours; in August, the same quantity of radium

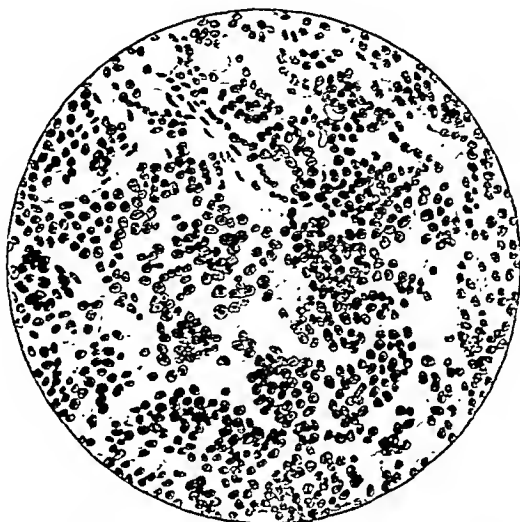


FIG. 113.—Section of lymphosarcoma from portion excised before commencement of radium treatment.

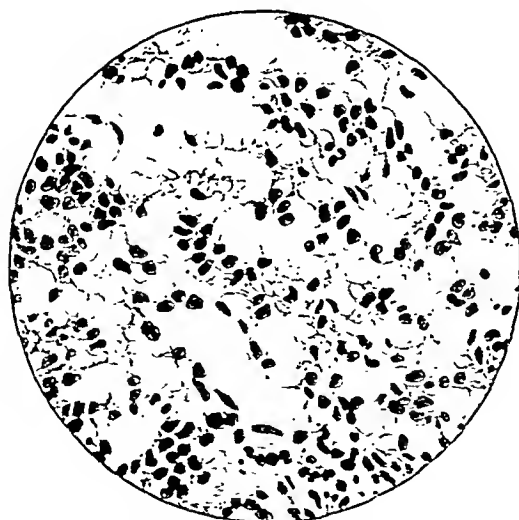


FIG. 114.—Section of growth removed post mortem six months after commencement of radium treatment: showing some degree of degeneration and slight fibrosis.

was again inserted for the same period. The growth had progressed (*Fig. 112*), and in September appeared on the right side of the neck. Radium was again applied, and a small piece of growth removed to ascertain what changes the radium had caused. *Fig. 114* is a microscope drawing of the tumour. The tumour grew steadily on both sides of the neck, and the patient died on Nov. 3, 1922.

4. **Sarcoma of Femur.**—The three cases of periosteal sarcoma of the femur were inoperable when they came under treatment; in each case secondary deposits were present in the lungs. The size of the primary growth diminished as a result of local insertion of radium combined with X-ray therapy. Death in all cases was due to pulmonary metastases.



FIG. 115.—Photograph of periosteal sarcoma of femur before radium application.

discovered. Skin not discoloured; no solution of continuity; skin not adherent except for a small area posteriorly. The tumour was fixed to the femur. No egg-shell crackling. Slightly tender to touch. Knee fixed in slight flexion. Liver not palpable. Spleen not felt. No glands. Some dullness in both lungs behind, alongside vertebræ. Secondary deposits confirmed by X rays.

OPERATION, March 17, 1921.—A small incision was made in the anterolateral aspect of left thigh over the most prominent part of the tumour. A small piece of the tumour was removed. Macroscopically the tumour looked malignant, and there was no capsule over it. Through the incision 60 mgrm. of radium were inserted for twenty-four hours. The tumour proved on microscopic examination to be a spindle-celled sarcoma (Fig. 116). On March 25 a quantity of

Case 1 (Figs. 115–118).—William L., age 26, married, two children, was admitted to hospital on March 16, 1921, complaining of a tumour in the left thigh. He gave the following history: In August, 1915, while a soldier serving in France, he received a blow on the left thigh from a clod of earth due to the bursting of a shell. He was invalided home twelve months later with a wasted leg. He was admitted to several Army hospitals during the following year, and was finally discharged from the Army in September, 1917, with a pension. In the spring of 1918 he first noticed that his leg was swelling; this gradually increased till March, 1921, when patient, who had been working as a fitter's mate, had to give up work and was admitted to hospital. On examination a firm hard swelling of the left thigh was

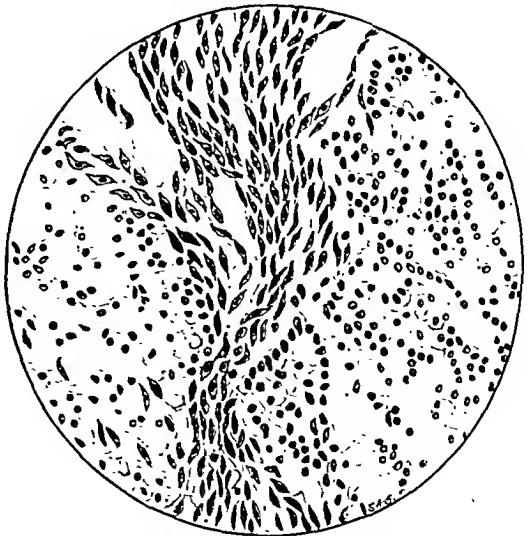


FIG. 116.—Section of periosteal sarcoma of femur before treatment.

radium emanation equal to 100 mgrm. of radium was inserted into the thigh for forty-eight hours. A blood-count was performed on April 9:—

Red blood-corpuscles	6,320,000 per c.mm. (126.4 per cent)	Polynuclear leucocytes ..	80.4 per cent
Hæmoglobin	98 ..	Eosinophils	3.3 ..
Colour index	0.77 ..	Lymphocytes	15.6 ..
		Mast-cells	0.7 ..

On May 12, 1921, 60 mgrm. of radium with a 1-mm. filter of lead were inserted into a secondary growth in the right lung. The 7th rib was resected and the lung exposed under intratracheal ether anæsthesia. The radium was removed after forty-eight hours.

On May 19, 60 mgrm. of radium with a 1-mm. filter of lead were again inserted into the left thigh for forty-eight hours. The thigh measurement had gone down from 28 in. to 25 in., and patient had gained one stone in weight. Blood-count, May 27, 1921:—

Red blood-corpuscles	4,068,000 per c.mm.	Polynuclear leucocytes ..	76.8 per cent
White blood-corpuscles	3,600 ..	Eosinophils	5.2 ..
Hæmoglobin	60 per cent	Lymphocytes	13.2 ..
		Mast-cells	3.8 ..

On June 3, 60 mgrm. of radium with a 1-mm. filter of lead were inserted into the left thigh for forty-eight hours, and again, on June 18, 60 mgrm. of radium with a 1-mm. filter of lead were inserted into the right thigh for forty-eight hours. On July 9, 60 mgrm. of radium with a 1-mm. filter of lead were inserted into a secondary deposit in the left lung under intratracheal anæsthesia, a portion of the 7th rib having been resected. The radium was removed after forty-eight hours. The patient began to lose weight and to go downhill rapidly after the middle of July, and died on Aug. 1, 1921.

POST-MORTEM EXAMINATION.—Was performed on Aug. 2. The left thigh was amputated and sectioned (*see Figs. 117, 118*). It was a periosteal sarcoma of the spindle-celled variety. There were no growths in the liver or any other abdominal organs. The growths in both lungs were considerably smaller than at operation. There were some mediastinal glands affected with growth.



FIG. 117.—Photograph of femur and growth removed post mortem.

This man received during his stay in hospital the following X-ray treatment:—

March 19: X-ray treatment to thigh—9 ports of entry 2 in. square: 6-mm. filter of aluminium; one full pastille dose to each area: 62 pastille doses given to thigh between March 19 and May 10.

March 22 : Chest divided into 16 areas 2 in. square ; 6-mm. filter ; full pastille dose to each area ; two areas each day ; 88 pastille doses given to chest between March 22 and July 17.

5. Carcinoma of Lip.—The two cases of carcinoma of the lip were inoperable on account of secondary deposits in the glands of the neck which infiltrated deeper structures. Each case was remarkably unresponsive to radium treatment ; the needles of radium were buried in the growth in the usual manner.

6. Carcinoma of Thyroid.—The case of carcinoma of the thyroid, although

large doses of radium were inserted into the growth on several occasions, did not seem to be at all influenced, but the tumour gradually grew and caused the death of the patient within a year of the diagnosis being made.

7. Carcinoma of Mouth.

—The four cases of inoperable carcinoma of the floor of the mouth were quite unresponsive to radium treatment.

8. Carcinoma of Cervix

Uteri.—Of the three cases of carcinoma of the cervix, two died within nine months of the first insertion of radium ; whereas the other patient, though considered inoperable at the time radium was in-

serted, was operated upon subsequently, and is still alive eighteen months after hysterectomy. The notes of this case are given below :—

Mrs. Ada G., age 58, came under observation in July, 1922, complaining of continuous slight hæmorrhage per vaginam. On examination the cervix was ulcerated and was fixed in position to surrounding structures. A diagnosis of inoperable carcinoma of the cervix was made. A small piece of tissue was removed from the cervix, and was found on microscopical examination to be malignant. Radium, 125 mgrm., with a 2-mm. platinum screen, were inserted into cervix for twenty-six hours. Two months later, on Sept. 15, patient was again examined under an anæsthetic. The cervix was now nearly flush with the vaginal vault and looked healthy. There was no sign of ulceration. In the right fornix only slight thickening could be felt ; whereas at the previous examination the pelvic cellular tissue appeared to be extremely involved and fixing the uterus, now the uterus was mobile in every direction. On Sept. 28, 1922, Wertheim's hysterectomy was performed ; the operation was quite easy.

On examination of the parts removed, the cervical canal presented what appeared to be a typical endocervical carcinomatous ulcer. This part was examined by the pathologist, who reported as follows : " Very little epithelium appears in any of the section ; such as there is shows no definite evidence of malignancy."

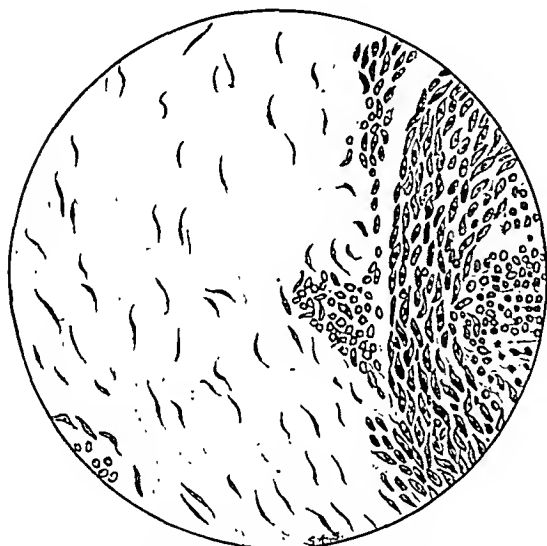


FIG. 118.—Section of growth showing marked fibrosis only after radium treatment.

"There are marked necrotic changes, hyaline degeneration, and fibrosis of the muscular coat."

The patient recovered well from the operation, and has put on half a stone in weight since leaving hospital.

CONCLUSIONS.

As regards the mode of action of radiations upon living tissues, various views have from time to time been put forward, such as that the radiations decomposed the lecithin present in the tissue cells, and that its disintegration products acted in an ingenious manner. As a matter of fact this action upon lecithin has not been substantiated by subsequent research.

Another view is that of specific activation of intracellular enzymes. Here, again, most recent investigations fail to demonstrate any such action, and our experiments at King's College Hospital upon the oxidases laccase and tyrosinase fail to show any effect as to sequel to irradiation.

Probably no one theory can explain all the phenomena; but what does seem clearly established is that X rays and the γ radiations from radium have a marked effect upon certain classes of colloids, among which are proteins and starch. Proteins undergo a marked diminution in viscosity, and are more easily precipitable after a radiation than before. In the case of starch, as shown by Colwell and Russ⁶ in 1912, this undergoes at any rate a partial change into soluble starch and dextrin.

It seems not improbable that certainly one of the effects of radiation is disturbance of the colloidal equilibrium of the cells, with consequent devitalization. If not carried too far the cell may recover, but if certain limits be exceeded the damage is irreparable, and the intracellular enzymes may then come into play, their action being of a destructive character upon the devitalized cell protoplasm.

The author wishes to acknowledge the kindly interest and assistance given him by his surgical colleagues, and by Dr. H. A. Colwell, Assistant Radiologist at King's College Hospital.

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THE SURGICAL TREATMENT OF OSTEO-ARTHRITIS.

(Being the Hunterian Lecture delivered at the Royal College of Surgeons of England on February 6, 1924.)

By C. MAX PAGE, LONDON.

THE chronic joint change recognized in England as osteo-arthritis, and on the Continent as arthritis deformans, is so general in its incidence that its milder forms may almost be regarded as a degenerative process associated with senescence. In certain cases, however, it assumes the character of a destructive pathological process, and may progress to such a degree as to produce serious disability, not only from pain, but on account of deformity secondary to absorption of bone. Moreover, the condition is by no means confined to those past middle age, and when it occurs early in life it seems to run an unusually active course.

The gross anatomy of the joint changes in osteo-arthritis has for long been clearly recognized, and industrious research has been carried out with a view to determining the cause of the condition. It must be admitted that though it has been demonstrated that the joint changes classified as osteo-arthritis may be initiated by several different factors, its etiology still remains obscure. The literature on the subject has become enriched with a confusing nomenclature which has developed as a result of the attempt to classify the various joint changes observed, generally on an anatomical basis. This aspect of the subject was very thoroughly reviewed here last year by Mr. Timbrell Fisher;¹ and at a discussion held at the Royal Society of Medicine² a few months later, what may be termed the medical side of the matter was fully debated.

I propose to devote my attention to a consideration of the treatment of cases in which the changes have so far progressed as to be beyond satisfactory relief by medical means. I shall simplify the subject further by omitting reference to conservative surgical methods, and shall confine myself strictly to a detailed consideration of the limited group of cases in which operative procedures can be held justifiable with a view to effecting a radical cure of the condition.

I do not wish to suggest that the more scientific, or even the empirical, procedures which have been applied to check the advance of the condition should be neglected as useless. There are two factors which are generally accepted as responsible for the progression, if not for the initiation, of this destructive process in a joint; they are (1) the presence of a chronic infective focus in some part of the body, and (2) strain or injury of the affected joint. Accepting these etiological causes, treatment directed to their elimination is a natural sequence. It is clear that the removal of any septic focus discovered in the body should not only be part of the treatment in early cases, but should receive equal attention in the more advanced instances in which operation is

contemplated. Rest of the joint involved is definitely suggested when there is pain.

How far the continuation of rest should be pursued with a view to obtaining an approximate cure by stabilization of the joint is an important question to decide, but one which it is difficult to answer. It is sometimes stated that rest and immobilization of an osteo-arthritic joint leads to its ankylosis. From my observation I doubt if a complete bony ankylosis ever results from the osteo-arthritic process unless a definitely inflammatory reaction is added to the ordinary picture. None the less, stability may be obtained by conservative treatment in an osteo-arthritic joint, at any rate sufficient to prevent the progressive absorption of bone, and to reduce the pain to an endurable degree. Once a joint has been denuded of its articular cartilage, progressive absorption will inevitably continue if any considerable range of movement is retained, and if it bears continuous weight. This point must be borne in mind when the selection of the type of operation best suited to the relief of the condition is made.

THE SELECTION OF CASES SUITED TO OPERATIVE TREATMENT.

The primary indications for recourse to radical operation in an osteo-arthritic joint can, I think, be clearly defined as two in number, viz., (1) persistent pain, and (2) progressive deformity in relation to the joint affected. These indications hold good whatever anatomical form the disease assumes, and whether the principal causative factor appears to be trauma, bacterial infection, or toxic absorption. Operation will not usually be undertaken in the presence of evidence of active infection. In young people it may be employed to cut short the uncertain period (always a matter of years) in which stabilization of the joint may occur under non-operative treatment.

In practice the selection of cases for operation will be influenced by the number of joints involved, and the life expectation of the patient. In those cases in which one joint alone is seriously affected, and when there is no suggestion of a general infective process, the decision to operate is a straightforward one. When, on the other hand, the disease is polyarticular in its distribution, operation will only be undertaken to relieve intolerable pain, or to correct disabling deformity after the infective process has become quiescent.

Operations for intercurrent complications of an osteo-arthritic process in a joint, such as the removal of hypertrophic villi or loose bodies, are often resorted to, but they hardly come within the scope of this paper.

The procedures which have been put forward in order to deal radically with osteo-arthritic joints may be roughly classified under three headings, viz.: (1) *Excision of the joint*; (2) *Arthroplasty*; (3) *Erasion of the joint*; (4) *Synovectomy*. The aim of these operations in regard to the final function of the articulation varies considerably.

1. Excision of the Joint.—This is the oldest established procedure in the surgery of this condition.^{3, 4, 5} Its primary aim is to relieve pain by the removal of the diseased joint surfaces. The functional result expected in the

cases of hip, elbow, wrist, and metatarsal phalangeal joint of the toe is a pseudo-arthritis. In the knee an arthrodesis in a good position is aimed at.

2. Arthroplasty.—The modern formal arthroplastie operation has not had an extensive trial in the treatment of osteo-arthritis, though it is favoured by some in the cases of the great-toe-joint. The operation is generally held to be an undesirable one for this condition, on account of the presumption that the new joint formed will undergo the same pathological changes as were responsible for the primary condition. Though there is evidence that this attitude is a reasonable one in the case of a weight-bearing joint, I do not think it need be adopted in respect of those articulations in which movement is only called for occasionally.

3. Erasion.—Erasion of a joint consists in removing the remaining articular cartilage and the underlying or exposed sclerosed bone, the general bony formation of the joint surfaces being retained. The final aim of this operation is generally to produce an arthrodesis, or at any rate fibrous ankylosis of the joint in a good position. In practice it will be found, as is shown in *Table I*, that in a fair number of cases this operation may leave a joint with quite a good range of movement.

4. Synovectomy.—This is essentially a conservative operation, which can only be expected to be successful in those cases in which little or no change has occurred in the articular cartilage; and it must therefore be undertaken at an early stage of the case. A radical synovectomy appears to have been first carried out by Müller⁶ in 1894. He based it on the hypothesis that the destructive process in an osteo-arthritic joint was initiated in the synovial membrane. Few operations of this character have been recorded, and so the evidence of the truth of the theory is lacking. The class of case which appears to be satisfactorily dealt with by this means is that termed lipoma arborescens or hypertrophic villous synovitis. The condition is most commonly seen in the knee-joint, and from an examination of specimens the disease appears to be primarily synovial, gross deterioration in the articular cartilage only occurring in the later stage of the process.

The decision as to which of these operations should be employed, and also the nature of the after-treatment, varies considerably in respect of different joints; and I will now give some consideration to the more important individual instances.

THE LOWER EXTREMITY.

The Hip-joint.—The pathological condition of the hip-joint associated with severe symptoms varies widely. The X-ray appearances always show reduction in the normal inter-articular space, on account of the absorption of articular cartilage; the degree of bone deformity may be slight or gross. This conforms to the rough division into atrophic and hypertrophic types. The atrophic form is most often seen in women and young adults, the hypertrophic being commoner in middle-aged and elderly men. A chronic arthritis initiated by a definite bacterial infection (e.g., the gonococcus or dysentery bacillus) will show approximately the same X-ray appearances as the atrophic type of osteo-arthritis. In those cases associated with old fractures of the

acetabulum, the appearances are influenced by the form of the primary injury. (*Figs. 119-122.*)

The choice of operation in this joint depends little, however, on the anatomical condition or etiology, but is determined by the age and general condition of the patient. In the young and middle-aged the aim should be not only to remove any pain but to provide a stable joint. This can be most effectually done by producing bony ankylosis at the joint line. An arthrodesis is most certainly produced by a complete erasion of the joint,



FIG. 119.—Hyperostrophic osteo-arthritis of hip (*Case 31*).

followed by fixation in plaster-of-Paris in the position of election for a sufficient time to allow bony union to occur. This procedure was first advocated by Albee⁷ in 1908. In his early series he merely rawed the upper surface of the femur and corresponding aspect of the acetabulum (*Fig. 123*). Latterly he has adopted a more thorough exposure of the joint, and further ensures bony ankylosis by the insertion of an autogenous bone graft.

The operation must be regarded as a severe one, though in my experience it is not associated with much shock. It is the prolonged after-fixation in

plaster-of-Paris in the recumbent position which is found most trying by the patient. The functional results of a fixed hip in a satisfactory position are remarkably good in the younger subjects. The most serious disability noticed as a rule by the patient is the difficulty he experiences in doing up his own boot on the side affected.

In reviewing the later results it is noticeable that elderly subjects sometimes develop pain in the lumbar spine and sacro-iliac joints after an arthrodesis of the hip. The fixation of the hip undoubtedly imposes a serious strain



FIG. 120.—Osteo-arthritis of hip with little bone change except at margins (*Case 4*).

on these joints. In elderly feeble patients an arthrodesis should not be attempted. A simple excision of the head of the femur has been most often favoured. Sir Robert Jones advises the production of a pseudo-arthritis at the base of the neck of the femur without touching the diseased joint. Both these latter operations relieve severe pain, but leave a joint of poor stability, and mean that the patient is left dependent on the use of crutches or a walking caliper.

Sampson Handley introduced the more conservative procedure to which

he gave the name cheilotomy, but there are few cases in which this operation could be expected to give a lasting cure. Platt advocates a partial excision of the head of the femur, leaving sufficient bone to engage the upper rim of the acetabulum. This leaves, in favourable cases, a stable joint with fair mobility.

In my own experience the operation of erosion of the joint has been well tolerated by old patients, and I have merely varied the after-treatment in their case by making no attempt at rigid fixation in plaster-of-Paris. A painless fibrous ankylosis or pseudo-arthritis is in this way obtained in a relatively short time; the hip is stable, but there is a tendency to the development of an adduction deformity.

The performance of a formal arthroplasty in the case of the hip-joint is a doubtful policy, and is hardly necessary in cases of osteo-arthritis. As stated above, a useful range of movement at the hip is obtained by an erosion of the joint followed by suitable after-treatment. Indeed, it is not easy to secure a sound bony ankylosis at the hip-joint, as is made clear by results seen in *Table I*. This experience falls in line with the frequency with which a pseudo-arthritis is formed after an unimpacted intracapsular fracture of the neck of the femur. This suppression of new bone-formation within the joint is due to the exposure of the broken surfaces to the influence of synovial fluid: the same condition prevails



FIG. 121.—Osteo-arthritis of hip with commencing dislocation (Case 28).

after an erosion or excision of the hip for a non-inflammatory condition.

In examining the later results (*Table I*) of cases of operation on the hip-joint, the tendency to the development of an adduction deformity is striking. This deformity results in serious functional shortening of the limb, from tilting of the pelvis when the erect attitude is assumed. As it is manifestly a complication to be avoided, it is worth while to examine the factors which are responsible for its production.

Adduction deformity is a notable feature in any case of destructive disease of the hip-joint. It appears to be due to at least two causes: (1) The proportionately excessive wasting of the gluteal muscles, which lie in intimate relation to the joint: the adductors, which are normally the master group,

are at a greater distance from the articulation and do not suffer so severely. (2) The abducting power of the glutei and tensor fasciæ femoris is reduced by the shortening of the lever (the neck of the femur) through which they act. Both these factors are operative in some degree after the operation



FIG. 122.—Traumatic arthritis of hip following an injury, presumably a fracture of the margin of the acetabulum (Case 18).

under consideration. Firstly, the muscles may be mechanically damaged or the nerve-supply interfered with if the incision is not carefully planned; secondly, any considerable removal of bone from the head of the femur, or unusual deepening of the acetabulum, will shorten the lever through which the muscles act.

The problem of avoiding the secondary development of adduction deformity after operation only arises when a fibrous joint is the result. If firm bony ankylosis is obtained in a good position by means of proper fixation, the difficulty does not arise; but it should be remembered that sound bony union is not always obtained, however carefully the operation may be carried out, and that union, apparently firm, if due to fibrous tissue, is liable to gradual stretching.

In all cases, therefore, of operations of this nature, the two simple mechanical factors above enunciated should receive attention, viz., (1) preservation of the full function of the gluteus medius and minimus and tensor fasciæ femoris, and (2) the preservation of the neck of the femur at as full length as possible. In practice, the adductors may be weakened by section of their tendons, followed by forced abduction of the thigh. To correct the result of shortening of the neck of the femur, Whitman⁸ advocates the reimplantation of the bony insertion of the gluteus medius and minimus into the shaft of the femur a couple of inches below the normal position of the great trochanter. I have no experience of this procedure, but it seems to be based on sound lines.



FIG. 123.—Diagram of Albee's method of producing a bony ankylosis in the hip-joint (1912).

The Knee.—This joint, next to that of the big toe, is probably most commonly the site of serious osteo-arthritis change. It may be said at once that, as far as current general experience goes, a radical cure of osteo-arthritis of the knee can only be obtained with certainty by arthrodesing the joint. Such a final destructive procedure can only be justified in those cases in which pain is severe and persistent, or in which absorption of the bone of the outer condyles has deformed the joint. (*Fig. 121.*)

Many minor operative procedures, favoured by the size and accessibility of the joint, have had a fair trial. The removal of detached and sessile osteophytes, and the resection of enlarged processes of the synovial membrane, are often carried out for the relief of symptoms, though it is not expected that such operations will bring the morbid process to a standstill. The more radical procedure of complete synovectomy is a practical possibility in this joint, and can be applied to a limited number of cases.⁹ When practised on those in which the chief and apparently primary change is in the synovial membrane, it has given satisfactory results.

I have found no records of a formal arthroplasty of the knee-joint in osteo-arthritis. Although the procedure cannot be regarded as likely to give a new joint permanently free from absorptive change, it should certainly be worth a trial in young patients. It is essentially conservative, and, if not successful, it should not prejudice the production of sound bony ankylosis at a second operation.

The Ankle.—Osteo-arthritis changes in the ankle are commonly originated by a trauma about the joint. It is not an uncommon sequence of infected compound fracture of the leg. The operative treatment of the condition has, in my experience, which has been limited to this type of case, been disappointing. Arthrodesis of the ankle-joint relieves the condition for a while, but is often followed after some months' use of the limb by the development of pain in the tarsal joints. The practice of arthrodesing the mid-tarsal joints at the same time as the ankle I have not found satisfactory. Pain in some part of the arch of the foot in front of the fixed joints commonly appears. I have actually carried out a Syme's amputation at the request of the patient in two cases a year or so after the complete arthrodesing operation had been done.

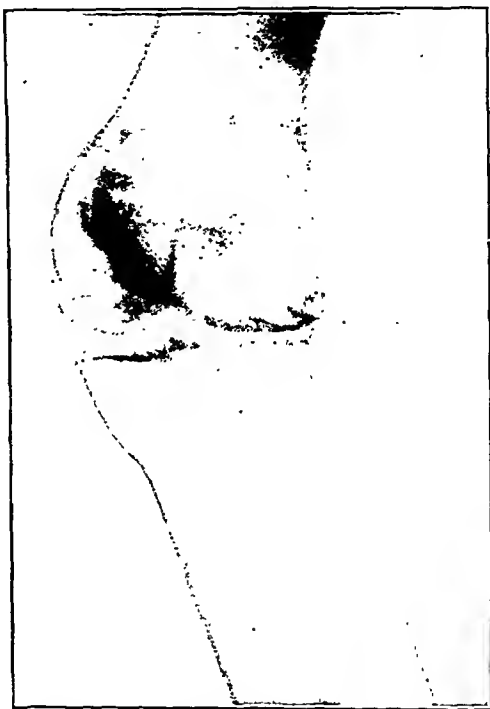


FIG. 121.—Severe osteo-arthritis of knee in a woman, age 47, with valgoid deformity.

A simple astragalectomy I do not think is much more satisfactory. The new joint between the tibia and the os calcis practically always becomes painful and develops arthritic changes. If resection of the astragalus is followed by the establishment of an arthrodesis between the tibia and upper surface of the os calcis with the foot dorsiflexed to 80 degrees, the functional results seem to be better.

My experience of the late results of operative treatment of osteo-arthritis in this joint seems to be at variance with some authors ; this is perhaps because it has been limited to cases in which widely diffused sepsis had been present at the inception of the condition.

Tarsus.—According to my observations the results of operation on the tarsal joints are not more satisfactory than those on the ankle. It seems that in the adult foot the removal of any substantial part of the bones of the tarsus imposes an irregular strain on the remaining joints, and seldom gives a good functional result. This is certainly true when the process has been associated with a pyogenic infection. In cases of simple fractures in civil practice where the arthritis is strictly confined initially to the injured joint, early operation may be more effective.

Metatarsal Phalangeal Joint of the Big Toe.—This joint is of interest in that it has furnished a mass of material from which one might expect to gather evidence of the value of operation on osteo-arthritic joints in general. The evidence, however, is not generally applicable, and certainly not in relation to weight-bearing joints. The operation undertaken has usually aimed at an arthroplasty. That generally practised takes the form of a free excision of the head of the metatarsal bone. Macausland and others practise a more conservative arthroplasty, inserting a fascial flap. In general the results of these excision operations is to leave a free or almost free joint which cannot be subjected to much strain.

A careful examination of the late end-results of these cases is certainly needed before a final opinion can be formed on the true worth of the several methods advocated.

THE UPPER EXTREMITY.

The joints of the upper extremity, though often enough the site of an osteo-arthritic change, will less often warrant radical operation than is the case in the lower limb. The disease does not tend to progress so far as in the lower extremity, because the joints do not bear weight and can be spared a good deal of their usual share of work without completely disabling the patient. A certain number of severe nonarticular instances of the disease are, however, met with ; they are generally secondary to trauma. If the condition occurs in working men, operation is the only measure which will restore them to full industrial efficiency.

Acromioclavicular Joint.—Osteo-arthritis of this joint may produce a chronic disability generally recognized as a 'painful shoulder'. The excision of the joint is a minor operation which can easily be carried out, and it gives most satisfactory results if the cause of the pain has been correctly located.

The Shoulder.—The accurate diagnosis of the cause of chronic pain about the shoulder is by no means easy. Exploratory operation may be necessary to

establish it. From my limited experience of the operative treatment of osteo-arthritic conditions in this joint, I should say that, though gross bony deformity of the articular surfaces is uncommon, the minor operations undertaken for the removal of enlarged bursæ, etc., seldom give permanent relief. If radical operation is felt to be justifiable, an arthrodesis of the joint, with the humerus abducted 45 degrees from the normal and externally rotated and anteverted, probably gives the best functional result: the scapular movements being sufficient to secure a useful control of the position of the arm. A simple conservative resection of the head of the humerus is a better procedure if for any reason the movements of the scapula are restricted; or in elderly patients in whom the prolonged fixation which an arthrodesis requires is undesirable.

The Elbow.—Cases submitted to operation will usually be secondary to injury, and undertaken in the working period of the patient's life. The decision between an arthroplasty and an arthrodesis will be based on social grounds. An arthrodesis between the elbow and humerus with the elbow set at an angle of about 130 degrees gives a very useful arm for a worker, provided that the head of the radius is freely excised, so that the

movements at the radio-ulnar joints are maintained. An arthroplasty is better suited to women, and to men whose occupation is of a sedentary character.

The Wrist and Carpal Joints.—Osteo-arthritis of these joints is most often seen as the late sequel of carpal injuries. Operation will be undertaken for persistent pain rather than for limitation of movement. In my experience of some eight cases, excision of the proximal row of carpal bones, though very

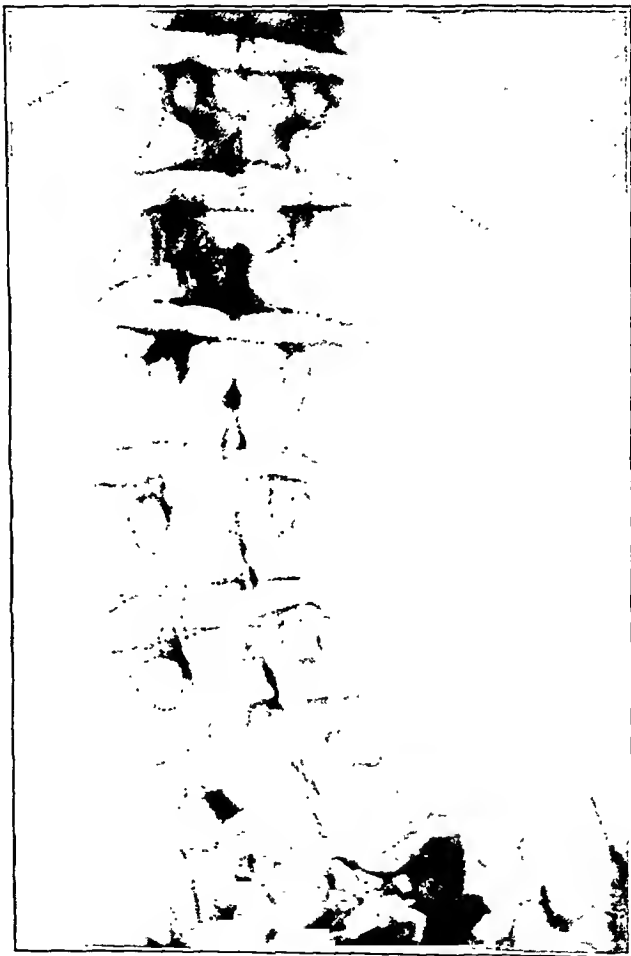


FIG. 125.—Traumatic spondylitis in a man, age 33.

often satisfactory in its immediate results, is disappointing later, a recurrence of the symptoms being common. A complete excision of the carpus is advocated by Vallas²⁰ for this condition. My experience of this somewhat drastic procedure is limited to two cases, and the final results showed little improvement on the primary condition.

In a working man the disablement is a serious one, and the poor results obtained by operation once the osteo-arthritis process is established enforces the importance of the careful early handling of cases of carpal injury.

Temporomaxillary Joint.—A disabling arthritis of this joint is most often met with in women. An excision of the condyle relieves the pain and leaves a useful joint. A shortcoming of the procedure is the slight deviation of the lower jaw towards the operated side which is involved.

The Spine.—The types of chronic change which can be recognized from the X-ray appearances can be roughly divided into two groups, viz. : (1) Those in which the bony changes are most in evidence, absorption of the bodies and marginal lipping being present (*Fig. 125*); (2) Those cases in which



FIG. 126.—Spondylitis deformans in a man, age 36, showing ossification of intervertebral ligaments and little other change.

ossification of the intervertebral ligaments is the prominent feature (*Fig. 126*).

In the latter type the serious clinical symptom is fixation of the spine due to bony deposit in the ligamentous structures. This is not subject to surgical control, and treatment must therefore be limited to prevention of deformity while the process is active, and to the securing of ankylosis in

an erect posture. The condition occurs in what is termed the Marie-Strümpell type of arthritis, and is often associated with involvement of the large joints of the extremities.

In the first-mentioned condition, which is more properly classified as one of osteo-arthritis and is generally termed traumatic spondylitis, the progressive absorption of bone may lead to severe pain from pressure on the emerging nerve roots. In such cases the possibilities of ankylosing the spinal processes by means of Albee's or Hibbs' method is worth considering in selected cases. I have undertaken two operations of this kind, but at too recent a date to be able to form any opinion as to the value of the final result. If operation is carried out for this condition, it appears to me to be difficult to determine what extent of the spine should be fixed. I attempted to arthrodesis the whole of the lumbar spine in both cases referred to.

Sacro-iliac Joints.—Some prominence has lately been given to the pain arising in these joints, and it has been termed sacro-iliac strain. In a great number of instances the condition appears to be due to an active osteo-arthritis of the joint. When the obstinacy of the case justifies it, an arthrodesis would appear to be the best method of operative treatment, and this has been carried out by bone-grafting in a plane posterior to the actual joint. I have no personal experience of the results of the procedure.

TECHNIQUE OF OPERATION ON THE HIP-JOINT.

A good exposure of the hip-joint is not very readily obtained in a stout adult, and for any operation aiming at an erosion of the joint a good field of view is most important. The surgical approaches to the joint have been subject to a good deal of study,¹¹ and I propose only to outline those methods of which I have personal experience, and to examine the relative merits in relation to the subject under discussion.

In 35 consecutive operations carried out for chronic arthritis I have employed three routes, the posterior, the superolateral, and the supero-anterior.

The Posterior Incision (*Fig. 127*).—An oblique skin incision about 8 inches in length is made, starting at a point over the posterior inferior iliac spine, and extending forwards and downwards, terminating just external to the anterior margin of the great trochanter of the femur. The underlying gluteus maximus is split in the length of the incision; the sections are then retracted upwards and downwards to expose the posterior and upper aspect of the capsule of the hip-joint. The view is somewhat obscured by the pyriformis and gemelli. These may have to be divided to gain access to the joint, but retraction is often sufficient. This incision does not give a good field of view, and it may be difficult to recognize the exact position of the joint margin. Dislocation of the head of the femur cannot be effected with ease or certainty. I have employed

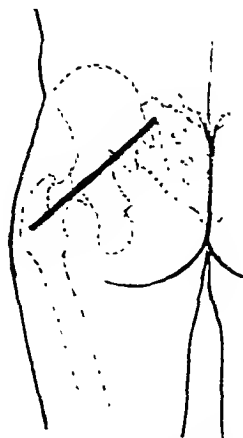


FIG. 127.—Diagram of skin incision: posterior approach.

this incision in five cases, but have given it up on the grounds stated above.

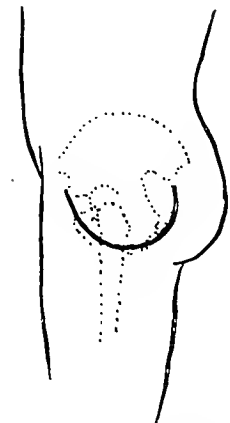


FIG. 128.—Diagram of skin incision: supero-external approach.

The Supero-external Route (*Fig. 128*).—This is based on that described by Murphy in his operation for arthroplasty of the hip, and also by Lexer. A skin flap is turned up representing a third of a circle: the anterior termination of the arc is brought over the anterior inferior spine, and the posterior lies in a similar relation to the posterior inferior spine. The flap is turned up on its base (*Fig. 129*); the underlying aponeurotic tendon of the gluteus maximus is divided in line with the anterior margin of the great trochanter. The tendinous flap is retracted backwards, exposing the great trochanter. This process of the femur is then cut through obliquely $\frac{3}{4}$ in. from its upper margin with a wide thin-bladed osteotome. The detached fragment of bone is drawn upwards with a sharp hook, and with it the insertions of the gluteus medius and minimus, pyramidalis, and gemelli; the anterior margin of the gluteus

medius is dissected away from the posterior aspect of the tensor fasciæ femoris in order to free the flap. A good exposure of the upper and posterior surface of the joint is so obtained; the joint line can be clearly recognized by a rotation of the thigh (*Fig. 130*). The capsule of the joint is incised from above downwards and backwards. The head of the femur can then be dislocated backwards by an assistant. The knee is bent to a right angle and the thigh partially inverted in order to effect this. Access to the acetabulum is obtained by a suitable manipulation of the position of the head of the femur. The joint surfaces of the head of the femur and acetabulum can then be cut away with a broad gouge. The head of the femur is dropped back into place, and the great trochanter and the overlying aponeurosis are then re-sutured in place. I have used strong catgut for the purpose, and have always secured bony union of the trochanter and shaft.

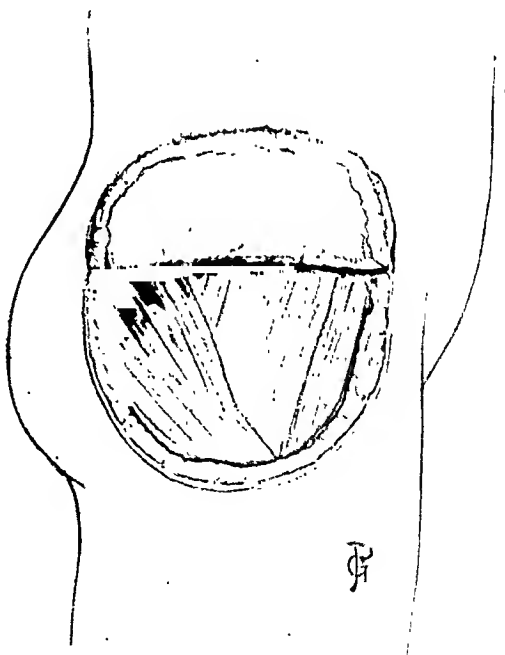


FIG. 129.—Diagram of area exposed by the skin flap in supero-external approach.

This route gives a good exposure of the joint, though in cases in which there has been gross deformation of the head of the femur complete dislocation may be found difficult or even impossible. The operation involves no division of blood-vessels of any size, and is absolutely conservative in regard to muscle function. I have used the method in twenty cases, and consider it certainly the most satisfactory for old patients on account of the rapidity with which it can be carried out and the small amount of muscle section which is necessary.

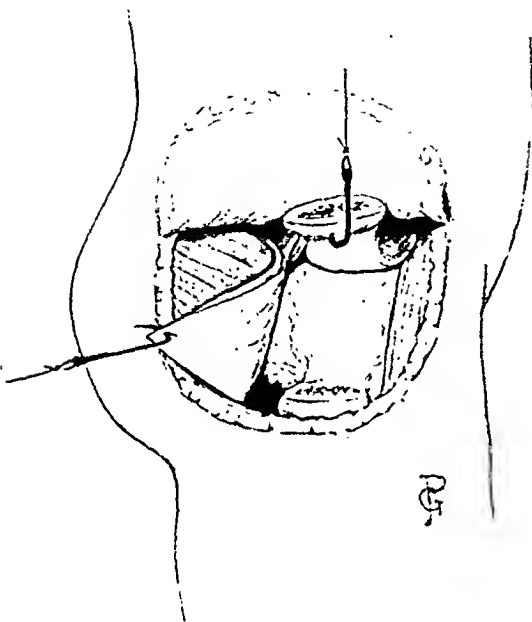


FIG. 130.—Supero-external approach: exposure completed.

incision directly downwards for about 5 inches. This vertical part of the incision lies over the border of the anterior portion of the tensor fasciæ femoris. The muscles are divided in the line of the skin incision; in the upper sector the origins of the gluteus medius and the tensor fasciæ femoris are cut through half an inch below the iliac crest (*Fig. 132*). In the vertical sector the fascia lata is divided at the anterior border of the tensor fasciæ femoris. The muscle flap so outlined is then separated from the underlying tissues, the gluteus medius being raised from the outer aspect of the venter of the ilium together with the underlying gluteus minimus. This exposes freely the front and upper aspect of the hip-joint, the reflected head of the rectus femoris lying immediately above it. In order to dislocate the head of the femur, the front part of the capsule must be incised and the outer border of the

The Supero-anterior Approach.

—This route was introduced in the early part of the century by Sprengel in Germany and by Anderson in England for operations on tuberculous disease of the hip-joint. The method was again described in detail by Smith-Petersen¹² in 1912.

The skin incision (*Fig. 131*) is angulated, and consists of an upper curved section about 4 inches in length, parallel to and just below the anterior half of the iliac crest, and a vertical cut made from the anterior extremity of this

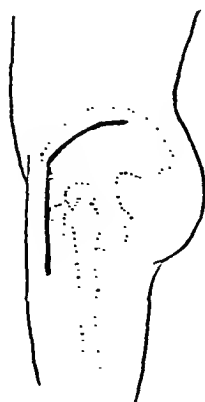


FIG. 131.—Diagram of skin incision: supero-anterior approach.

iliofemoral ligament divided. Dislocation is effected by an assistant strongly everting the thigh, after the latter has been flexed to a right angle.

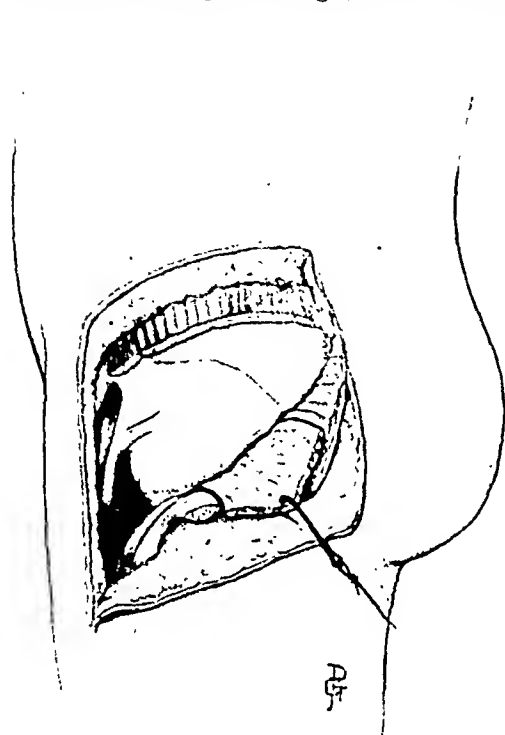


FIG. 132.—Supero-anterior approach: the muscle flap turned down.

This incision gives the fullest exposure of the joint, and renders the accurate recognition of the bony parts very easy. In children the gluteal flap can be raised subperiosteally, but in the adult this is not possible, and the separation of these muscles from the bone involves a good deal of minor bleeding. If the head of the femur is dislocated through this approach in order to effect a complete crasion of the joint, it should be noted that the iliofemoral ligament must be damaged; though this is of no importance if bony ankylosis is secured, it is not desirable if a movable joint results. The intact ligament is also, I think, of some importance in the maintenance of close bony contact of the rawed surfaces after operation. I have used the incision in nine cases, and, owing to the reasons stated, I am inclined to consider it not as satisfactory as the supero-external route.

TECHNIQUE OF OPERATION ON THE KNEE.

Excision of the Knee (Figs. 133–136).—When undertaken in osteoarthritis the aim of this operation is the production of sound bony ankylosis in a slightly flexed position. Classical methods, though usually successful in securing this result, occasionally fail, and union is established by fibrous tissue. The factors which may lead to union of this character appear to be three, viz., (1) sclerosis of the bone surfaces apposed, (2) lack of close contact between the prepared surfaces, and (3) the access of synovial fluid to the cut bone. The incidence of these factors can be prevented by attention to the following details: (1) The synovial pouch should be dissected out, the bulk of the synovial tissue in the joint being in this way removed; (2) The section of bone should be so planned that vascular cancellous bone is exposed everywhere except at the margins; (3) I have usually assured close apposition of the cut bone surfaces, without any special splinting, by pulling the patella down to the level of the tibia and pegging it in position there. The articular cartilage of the patella is previously cut off. The bone is most effectively



FIG. 135.—Side view of excised knee, Fixation secured by the use of beef-bone pegs.

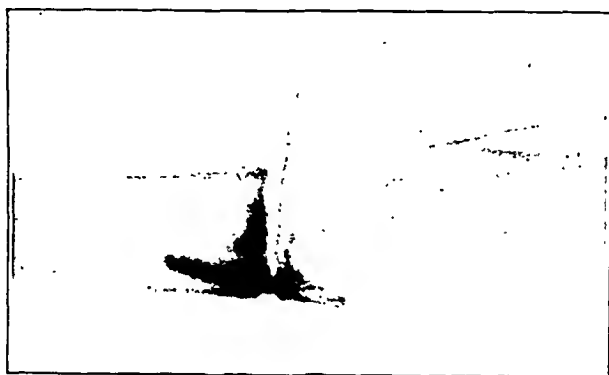


FIG. 134.—Side view of case shown in Fig. 133, after an autogenous key graft had been inserted to secure bony union: X-ray three months after second operation.



FIG. 133.—Fibrous union present in a knee excised two years previously. Male, age 42.

held by means of a long French nail. This procedure holds the bone surfaces firmly in contact by the tonic pull of the quadriceps muscle and its opponents. The method has the practical advantage that the cut surfaces are



FIG. 136.—Excision of knee fixed by nailing patella to tibia.

so firmly held in position that it is unnecessary to use plaster for fixation of the limb after the operation, a simple gutter excision splint being applied. A close-fitting plaster case can be fitted in a week or so after the skin stitches have been removed.

The only drawback to this method is that the pull of the quadriceps may be sufficiently strong to angulate the joint forwards, opening up the posterior aspect of the cut surfaces. This tendency can be controlled without difficulty when the plaster case is applied. This form of the operation can be carried out if the usual U flap of skin be turned up, but I think an H-shape incision is better. It gives full access to the operation area without involving the risk of marginal sloughing of the skin flap.

AFTER-TREATMENT.

Hip-joint.—The form of the after-treatment adopted is determined according to whether bony ankylosis is desired, or whether fibrous union at the joint is deemed sufficient. In young healthy subjects the satisfactory final results of an arthrodesis will settle the question. In elderly or feeble patients a fibrous joint will be accepted in order to minimize the discomforts of after-treatment.

In order to obtain bony union, I think satisfactory fixation in plaster-of-Paris is essential. A single spica extending from below the ribs to the foot is applied immediately after operation. The thigh is set in the position of election, viz., slight abduction, 20 degrees of flexion, with the foot slightly everted. The first plaster is changed in about a fortnight, when the wound stitches can be removed, and another is applied. The second plaster must control the abduction, and if this cannot be done by moulding the plaster on the pelvis, coupled with an extension to the axilla on the opposite side to the injury, the sound leg should be included. At six or eight weeks after operation the plaster is cut away in order to free the knee-joint. At eight to twelve weeks the patient can get about with crutches, retaining a short spica for another month. Weight-bearing is allowed during this period. At

three to four months after operation the plaster is removed and the condition of the joint examined radiologically; if union is firm, the patient can be allowed to walk with sticks. Full return of function cannot be expected under six months from operation, and may be deferred for twelve.

The ideal position for fixation of the hip varies somewhat in relation to the occupation of the patient. Flexion beyond 20 degrees involves considerable compensatory lordosis of the lumbar spine when the erect position is adopted. For this reason flexion in an outdoor labourer should not exceed that degree. In cases in which the patient wants to be able to drive a car of standard proportions, flexion to 30 degrees must be given unless the man is very short. *Case 20* is a good example of the functional result obtained in such cases; twelve months after operation he was able to pass the police taxi test, and now drives a cab daily.

Some fixation of the knee commonly follows the prolonged immobilization in plaster, but it is only likely to be permanent in elderly patients, the full range being restored on the average after a few weeks' physical treatment.

When the aim is fibrous union, after operation the limb is slung in a Hodgen's or similar splint and a light extension applied. The position maintained should approximately be that of election already described. The extension is removed at the end of three or four weeks, and the patient allowed to get up on crutches swinging the damaged leg. Weight-bearing is not encouraged till six weeks after operation. Though the period during which the patient is confined to bed is reduced, the final return of function is usually less rapid and less satisfactory than when an ankylosis is obtained.

The Knee-joint.—When the knee has been excised by the method described above, a simple metal gutter splint is applied, extending from the tuber to the lower part of the calf, for a couple of weeks. It is then replaced by a close-fitting plaster cast extending from the tuber to the malleolus. The patient gets up in from four to six weeks after operation, and walks with crutches for a month or so, gradually putting more weight through the joint. Union is generally firm in from three to four months.

LATE RESULTS OF OPERATION.

The Hip-joint.—In the estimate of the final results of these operations on the hip the views of the patient and surgeon are somewhat different. The former is well satisfied if he loses his pain and is left with a limb whose functional value is not worse than before operation. The surgeon, on the other hand, recognizes that the removal of the pain is readily effected, and looks rather for an improvement in the functional value of the limb. In either case the true merit of the procedure can only be fairly assessed by a study of the results some years after operation. This particularly applies if operation is undertaken during the active period of the patient's life, when the resulting function of the limb is almost as important as the relief of pain.

The evidence in the literature on the subject is somewhat meagre, only a few authors having published the details of the late results of any considerable number of cases. The outcome of operations aiming at arthrodesis have received the most attention.

Table I.—34 CASES OF OSTEO-AR

NO.	NAME	AGE AND SEX	SIDE	DATE OF OPERATION	CONDITION AND ETIOLOGY	OPERATION	APPROACH	DATE OBSERVED
1	Pens. S.	32 M.	R.	1.12.19	2 years treated as tuberculous hip. X-ray and histological examination showed chronic arthritis	Partial erosion. Head not dislocated. Fixed in plaster 2 months	Supero-anterior	1.2.21
2	F. F.	69 M.	R.	5.2.20	8 years progressive hypertrophic osteo-arthritis. Partial dislocation. Adduction and flexion +. Muscle spasm +	Partial erosion. Head not dislocated. Poorly fixed in plaster 6 weeks	Posterior	6.7.22
3	K. H.	43 F.	R.	6.3.20	3 years increasing pain and stiffness. Osteo-arthritis	Partial erosion. Head not dislocated. Fixed in plaster 2 months	Posterior	30.1.21
4	A. K.	60 M.	L.	4.4.20	10 years pain and stiffness. Hip flexed and adducted. Hypertrophic osteo-arthritis	Erosion of joint. Tenotomy of adductors. In plaster 2 months	Supero-lateral	10.1.21
5	Pens. E.	34 M.	L.	17.5.20	Fell from lorry 18 months before. X-ray: no fracture. Traumatic arthritis	Complete erosion of joint after dislocation. In plaster 2½ months	Supero-lateral	3.4.22
6	E. D.	48 F.	L.	29.5.20	4 years pain. Osteo-arthritis	Partial erosion. In plaster 6 weeks	Posterior	16.1.21
7	Pens. P.	42 M.	L.	3.8.20	2 years ago fractured neck of femur. Painful false joint	Excision of head of femur. Arthrodesis attempted by bone peg and fixation in plaster	Supero-lateral	1.2.23
8	W. S.	45 M.	L.	20.11.20	2 years ago fractured neck of femur. Union in bad position. Secondary arthritis	Partial excision of head. Fixation in plaster	Supero-lateral	10.1.21
9	Pens. F.	24 M.	R.	1.1.21	Ununited fractured neck of femur complicating paraplegia of obscure origin (? acute myelitis) 2 years. Hip flexed and adducted	Excision of head. Arthrodesis of neck without bone peg. In plaster 2 months	Supero-lateral	4.6.22
10	S. B.	55 F.	L.	16.1.21	Osteo-arthritis, nonarticular. 5 years increasing pain. Spasm +	Erosion of joint after dislocation	Supero-lateral	4.1.21
11	Pens. W.	38 M.	L.	4.4.21	2 years pain in hip. ? Psoas abscess, suspected of T.B. X-ray and microscopic: osteo-arthritis	Erosion of joint. Head dislocated	Supero-lateral	4.4.21

SURGICAL TREATMENT OF OSTEO-ARTHRITIS 171

JOINT TREATED BY OPERATION.

PAIN IN HIP	PAIN IN OTHER JOINTS	FUNCTIONAL SHORTENING	FUNCTIONAL VALUE	REMARKS
None	—	$\frac{1}{2}$ inch	Good. Working as a carter in 1922, full day, continues to do so	Walked with sticks 10 weeks after operation. Finds sitting awkward on account of absence of flexion at hip
None	—	4 inches	Fair. Can stand about without discomfort. Walks with stick	Patient had become addicted to morphia before operation on account of pain. There was much spasm of the hamstrings, which made fixation in plaster splint difficult
None	—	$1\frac{1}{2}$ inches	Can do all housework. Fair	Pyorrhœa \div . Knee remained stiff after operation for some months. Did not walk without crutches for 4 months. Now occasional pain and stiffness in R. knee
None	—	2 inches	Fair, but unable to resume old work as carter	
None	—	None	Very good	Returned to work, but committed suicide in 1922, said to be due to family worries
None	—	1 inch	Can walk about 2 miles in comfort	Patient was very stout and was difficult to fix in plaster. Very slow in recovering general ambulatory function (5 months)
Occasional	—	3 inches	Poor. Walks fairly in caliper	Arthrodesis failed in this case
None. Pain in L. groin after long day	—	3 inches	Good. Does full day's work as gardener	Original aim at procuring an arthrodesis failed. Present joint seems useful, but X-ray suggests progressive absorption of bone
None	Nil	2 inches	Incomplete recovery of paraplegia. Could walk 6 months after operation	Final result not observed
None	None except for occasional stiffness in R. hip	$1\frac{1}{2}$ inches	Can walk 2 miles on end and stand any length of time	Patient was of stout build and difficult to control in plaster
None	Some pain in L. knee and back	1 inch	Good	Patient of poor physique and lacking in enterprise: has not yet returned to work. Pain in back probably secondary to too great flexion of hip-joint

Continued on next page

Table I.—34 CASES OF OS

NO.	NAME	AGE AND SEX	SIDE	DATE OF OPERATION	CONDITION AND ETIOLOGY	OPERATION	APPROACH	LATEST DATE OBSERVED
12	Pens. C.	43 M.	L.	8.5.21	Dysentery 1916, followed by arthritis of spine and hips. Painful partial ankylosis of both hips	Erasion of joint after dislocation	Supero-lateral	27.1.24
13	W.W.	60 M.	L.	3.6.21	Progressive hypertrophic osteo-arthritis	Erasion of joint after dislocation. Fixed in plaster 2 months	Supero-lateral	4.7.23
14	Pens. D.	34 M.	R.	29.8.21	Osteo-arthritis. Few years increasing pain and stiffness	Partial erasion, dislocation not possible	Supero-anterior	3.4.23
15	Pens. Gil.	37 M.	R.	20.10.21	Traumatic arthritis following gunshot wound of hip, non-suppurative	Excision of remains of head of femur. Arthrodesis with beef peg	Supero-lateral	4.11.23
16	Pens. Greg.	34 M.	L.	7.11.21	Traumatic arthritis following gunshot wound. Painful hip fixed by spasm	Excision of head. Arthrodesis with beef peg	Supero-lateral	10.12.23
17	L. L.	51 F.	L.	24.1.22	Osteo-arthritis of hip 3 years. Early osteo-arthritis of both knees	Erasion of joint after dislocation of head. In plaster 2 months	Supero-lateral	7.9.23
18	Pens. M.	30 M.	L.	9.2.22	Traumatic osteo-arthritis. Hip stiff 4 years following an injury	Partial erasion of joint. Dislocation not complete. Plaster 2 months	Supero-anterior	1.2.24
19	J. E.	51 M.	L.	16.2.22	Osteo-arthritis. Wearing caliper splint 18 months	Erasion of joint after dislocation. Plaster fixation	Supero-lateral	7.1.24
20	R. L.	52 M.	L.	25.4.22	Hypertrophic osteo-arthritis 5 years	Erasion of joint after dislocation. Plaster 7 weeks	Supero-lateral	25.1.24
21	Pens. N.	43 M.	L.	19.5.22	Arthritis of hip following enteric in 1919. X-ray appearances: osteo-arthritis	Erasion of joint without complete dislocation	Supero-lateral	1.2.24
22	W.W.	66 M.	L.	6.6.22	Hypertrophic osteo-arthritis 5 years	Erasion of joint after dislocation. Fixed in plaster 6 weeks	Supero-lateral	9.11.22
23	H. B.	59 M.	L.	29.6.22	Hypertrophic osteo-arthritis 2 years	Erasion of joint after dislocation. In plaster 2 months	Supero-lateral	10.10.23

SURGICAL TREATMENT OF OSTEO-ARTHRITIS 173

TREATED BY OPERATION—continued.

PAIN IN HIP	PAIN IN OTHER JOINTS	FUNCTIONAL SHORTENING	FUNCTIONAL VALUE	REMARKS
None	Occasional in back	—	Can walk a few hundred yards	Arthroplasty of R. hip 5.3.21. Spine is stiff and kyphotic
None	L. knee occasional	1½ inches	Fair	Had not returned to his work as engine-driver in July, 1923
None	None	1 inch	Good	Returned to work as barman 7.7.22
None	None	2 inches	Good	Returned to work as upholsterer
None	Slight in lumbar spine	2½ inches	Good	Walked without stick 5 months after operation
Occasional in L. groin	In L. knee and both sacro-iliac areas	1½ inches	Poor 1½ years after operation. Could walk a mile or two	Swelling of whole 2 weeks after operation. No infection. Swelling gradually settled down, but L. knee somewhat stiff. Sacro-iliac pain was relieved in some measure by a Goldthwaite belt. Poor-hearted patient.
None, or slight in groin and thigh	None	None	Good. Works daily as milkman	Complained of awkwardness in sitting down due to slight degree of flexion of hip
None	Occasional in L. knee	1½ inches	Good. Can walk "any" distance	Returned to work as barnman
None	None	1½ inches	Good	In 1923, passed Metropolitan Police examination as taxi-driver, and now working as such. Unusual flexion of hip given on account of occupation.
Slight after heavy work in wet weather	None	1 inch	Good	Working as liftman
None	None	1 inch	Walking with sticks	Died, March, 1923: said to be from pneumonia
Some in groin	L. knee stiff and painful	2 inches	Poor. Could walk about a mile with a stick	Developed swelling in both legs 6 months after operation. Possibly due to venous thrombosis. Under medical treatment for emphysema and myocarditis

Continued on next page

Table I.—34 CASES OF OSTEO-AR₁

NO.	NAME	AGE AND SEX	SIDE	DATE OF OPERATION	CONDITION AND ETIOLOGY	OPERATION	APPROACH	LATEST DATE OBSERVED
24	F. T.	37 F.	L.	28.9.22	Osteo-arthritis of hip 2½ years, much pain in knee	Erision of joint after dislocation. Plaster 2 months	Supero-lateral	28.1.24
25	A. W.	50 M.	L.	5.12.22	Hypertrophic osteo-arthritis 6 years, progressive	Erision of joint after dislocation. Plaster 7 weeks	Supero-anterior	23.12.23
26	G. N.	59 M.	R.	2.1.23	Traumatic osteo-arthritis. Fell and broke ankle and hurt hip 3 years ago	Erision of joint after dislocation. Plaster 6 weeks	Supero-lateral	24.1.24
27	C. D.	48 F.	R.	15.5.23	Osteo-arthritis of hip. Pain 2 years. Pott's fracture of R. ankle 8 years ago, position poor	Erision of joint after dislocation. Plaster 2 months	Supero-anterior	7.11.23
28	Pens. P.	33 M.	R.	7.2.23	Hypertrophic osteo-arthritis with commencing dislocation	Erision of joint after dislocation	Supero-lateral	2.2.24
29	Pens. Strat.	38 M.	L.	7.5.23	Traumatic arthritis following fracture of acetabulum. Great flexion and adduction deformity at hip	Partial excision of joint. Dislocation impossible. Plaster 2 months	Supero-anterior	23.11.23
30	G. W.	64 M.	L.	10.6.23	Hypertrophic osteo-arthritis	Erision of joint after dislocation. No plaster fixation. Light extension 6 weeks	Supero-anterior	24.1.24
31	H. S.	48 M.	L.	27.9.23	Hypertrophic osteo-arthritis	Erision of joint, 4 lb. extension. On crutches in 5 weeks	Supero-anterior	24.1.24
32	H. P.	73 M.	R.	4.10.23	Hypertrophic osteo-arthritis 5 years	Erision of joint after dislocation. 4 lb. extension	Supero-anterior	—
33	Lt.B.	24 M.	R.	2.11.23	Chronic painful arthritis 2½ years	Erision of joint after dislocation. In plaster 8 weeks	Supero-anterior	28.1.24
34	G. L.	43 M.	L.	1.8.22	Hypertrophic osteo-arthritis	Erision of joint after dislocation. Fixed in plaster	Supero-anterior	27.1.24

SURGICAL TREATMENT OF OSTEO-ARTHRITIS 175

TREATED BY OPERATION—*continued.*

PAIN IN HIP	PAIN IN OTHER JOINTS	FUNCTIONAL SHORTENING	FUNCTIONAL VALUE	REMARKS
None	Some pain in R. hip, both sacro-iliac joints	2½ inches	Can walk 3 or 4 miles	A very short woman. Sacro-iliac pain improved by wearing belt.
None	Pain and stiffness L. knee	2 inches	Can walk a good distance with a stick	Returned to work as carpenter, Nov., 1923
None	None	1½ inches	Good	
None	In R. knee and ankle	2 inches	Fair	Walks with stick, but improving in regard to general function
None	None	1 inch	Good	Could walk 1 to 2 miles 10.11.23. At work as liftman 2.2.24.
None	None	1½ inches	Good	Complete reduction of flexion deformity was easily effected, but full reduction of adduction found impossible
Slight	None	2 inches	?	Walks 2 or 3 miles with a stick 24.1.24
Some in groin after walking	None	2 inches	?	Walks 2 or 3 miles with a stick, hip still feels weak 24.1.24
—	—	—	—	Died 10 days after operation. P.M.; cellulitis of wound; trabeculated bladder; cirrhotic kidneys. Uremic symptoms developed 3 days after operation
None	None	None	Good	Walking in short spica 27.1.24
Some in groin and thigh	Some in back	2 inches	Poor. Can walk half a mile	The resulting position 9 months after operation was fair; flexion and adduction increased latterly, and account for poor end-result

Ozarki¹³ in 1917 records the results of the arthrodesing operation of the hip in ten cases of polyarticular arthritis and sixteen of the monarticular variety. The same cases were reported on a few years later.



FIG. 137.—Result of operation in *Case 20*: two years after operation: bony ankylosis.

In 1920 Spiers,¹⁴ in a careful survey of the late results of all the cases operated on between 1908 and 1920 at Brackett's clinic, sets them out in tabular form as follows :—*

Cases operated on	..	..	..	34
Cases examined later and reported	..	..	..	25
Average age	..	..	..	46
Youngest	..	..	..	22
Oldest	..	..	..	61
Case mortality	..	..	..	2
Average interval since operation	..	..	..	4½ yrs.

RESULTS OF EXAMINATION.

<i>Union</i> :	Union firm	..	..	17	<i>Position</i> :	Adduction present in	18	
	„ questionable	..	..	3		Normal	..	4
	Non-union	5		Abduction present in	..	3

* These cases presumably include those reported in 1917 by Ozarki.

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He found that in the cases unrelieved by operation, arthrodesis had not been secured.

Albee⁷ in 1921 reported that he had operated on 128 cases with satisfactory results. Details of these cases in regard to the technique of operation and the late results are not published.

The results of the operation of excision of the head of the femur for this condition have not been reported in any large series. Individual experience

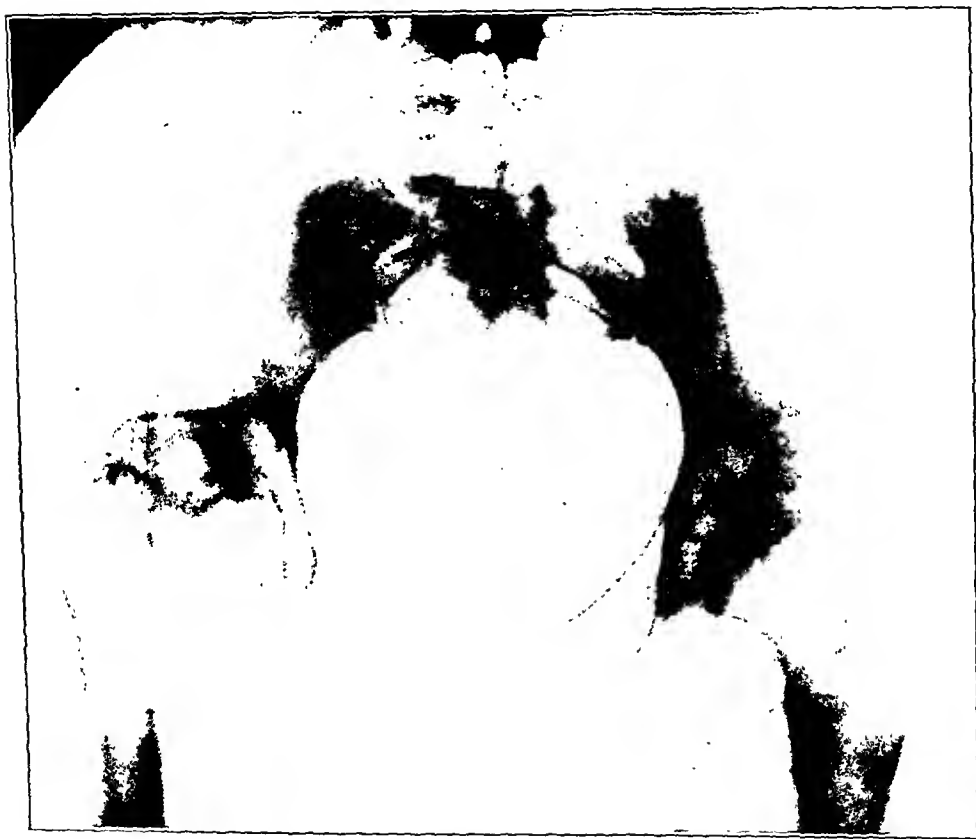


FIG. 138.—Result one year after operation in Case 24: bony fixation, with head of femur displaced somewhat upwards.

appears to vary. Pain is relieved in all cases, but the functional value of the joint is reported on as a whole unfavourably, considerable shortening being the rule, and stability uncertain (Fock³, Zezas⁴, Müller⁶, and Hoffa¹⁵).

Platt has reported to me that he has carried out a modified excision in some twenty cases. He considers that though pain is thereby relieved surely, the average function given by this operation is disappointing.

I have operated on 31 cases of chronic arthritis of the hip from 1919 to date. Details of these cases are given in *Table I*. The series is made

up of the following types: Monarticular osteo-arthritis, 28; polyarticular osteo-arthritis, 1; traumatic osteo-arthritis, 5. (*See Figs. 137-142.*)

In the 29 cases operated on for chronic arthritis, an crasion of the joint was effected by one of the methods previously described. After-treatment was carried out with a view to obtaining bony ankylosis in 23 cases, and a fibrous joint in 6. Six of these cases were operated on in 1923, and therefore are of no value in assessing the late results.



FIG. 139.—Result of operation for osteo-arthritis of hip: fibrous joint: X-ray eighteen months after operation (*Case 25*).

Table II gives in outline the late reports of the 24 cases in which operation was carried out between 1919 and 1922. The average age of these cases was 47.5, the oldest was 69 and the youngest 28. The results tabulated were obtained by clinical and X-ray examination made within the last few months. Three of these cases were not examined recently, one having died of pneumonia, one having committed suicide for domestic reasons, and the other reporting from the country. The statements in regard to the absence of pain are based on the patients' opinion, and refer to the original joint pain.

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The term 'slight pain' is applied to those cases in which ill-defined pain in the groin or thigh was complained of after fixation. The estimate of the functional value of the limb is necessarily approximate. No hard-and-fast classification is possible when dealing with this condition, the results varying in relation to the age of the patient, and the preceding period and degree of disability. The term 'good' has been applied when the patient could walk about five miles without any support, and do a fair day's work. 'Fair' implies the ability to walk about two miles and to stand about half an hour without fatigue. The category 'poor' is applied to those cases in which the ability to walk was limited to a mile or less.

Table II (abstracted from Table I).—GENERAL RESULTS IN 24 CASES OF ERASION OF HIP-JOINT REVIEWED AT LEAST ONE YEAR AFTER OPERATION.

CONDITION OF JOINT		POSITION	PAIN IN HIP		FUNCTIONAL SHORTENING	FUNCTIONAL VALUE	
Bony ankylosis	9	Normal ..	3	Absent ..	19	Average in inches 1·5	Good 13
Ankylosis ?	5	Adduction	19	Slight ..	5		Fair 8
Fibrous union	10	Abduction	2				Poor 3

As might be expected, the functional results are most often satisfactory in the younger patients, as is shown in the following table:—

Table III.—COMPARATIVE FUNCTIONAL RESULTS IN REGARD TO AGE.

AGE 20-49				AGE 49-79			
No. of Cases	Good	Fair	Poor	No. of Cases	Good	Fair	Poor
14	11	3	0	10	3	4	3

The relation of fixation to function is shown in the following extract:—

Table IV.—THE RELATION OF FIXATION TO FUNCTION.

JOINT CONDITION	CASES	RESULTS		
		Good	Fair	Poor
Arthrodesis	.. 9	9	—	—
? Arthrodesis	.. 5	2	3	—
Fibrous joint	.. 10	2	5	3

The nature of the incision employed does not appear to have much bearing on the question of the production of bony fixation. The relative merits of the approaches from a surgical point of view have already been considered.

In the five cases in which the head of the femur was excised on account of a painful ununited fracture of the neck, an attempt was made to effect an arthrodesis. In three cases a beef-bone peg was employed, and in the other two no special means of internal fixation were made use of. In the first three cases arthrodesis resulted, and in the other two a mobile and fairly stable joint was the result.

One fatality occurred in the series: a case (32) operated on in September, 1923. The condition was one of long-standing monarticular osteo-arthritis of the left hip in a man of 75. The patient died nine days after operation with symptoms of uremia. Post-mortem examination showed cystitis and infection of the kidneys. The fatal issue must be accepted as secondary to operation, but the patient was clearly



FIG. 140.—Fixation with beef peg after an old excision of head and neck of femur for a wound: X-ray nine months after operation: hip stable, function good.

unfitted for any serious operative procedure.

The Knee-joint.—In this joint the accepted opinion is that an arthrodesis resulting from an excision gives good results both with regard to relief of pain and the preservation of the use of the limb. I have carried out the operation in fourteen cases. Bony ankylosis resulted in all. In one case pain definitely persisted after operation. The patient was a man, age 30, apparently in good health. The Wassermann reaction was negative. There is firm bony ankylosis, and he is at work, but he still complains of deep pain in the region of the knee-joint two years after operation.

In two cases complaint was made that pain developed



FIG. 141.—Excision of head and neck of femur, to effect a false joint in right hip (Case 12). The femur has been allowed to drop out, and is not stabilized against the acetabular rim as should be done, by abducting the leg.

in the ankle-joint after much walking. This appeared to be due to development of a rheumatoid change in this joint. In both cases the knee was fixed in the fully extended position, and so the ankle was put through a very full range of movement in the action of walking.

Cases of synovectomy of the knee are reported by Müller and Swett. The former quotes three cases, all of which were stated to have remained relieved from two to four years after operation, the range of movement retained being fair. Swett's records are in relation to polyarticular infections

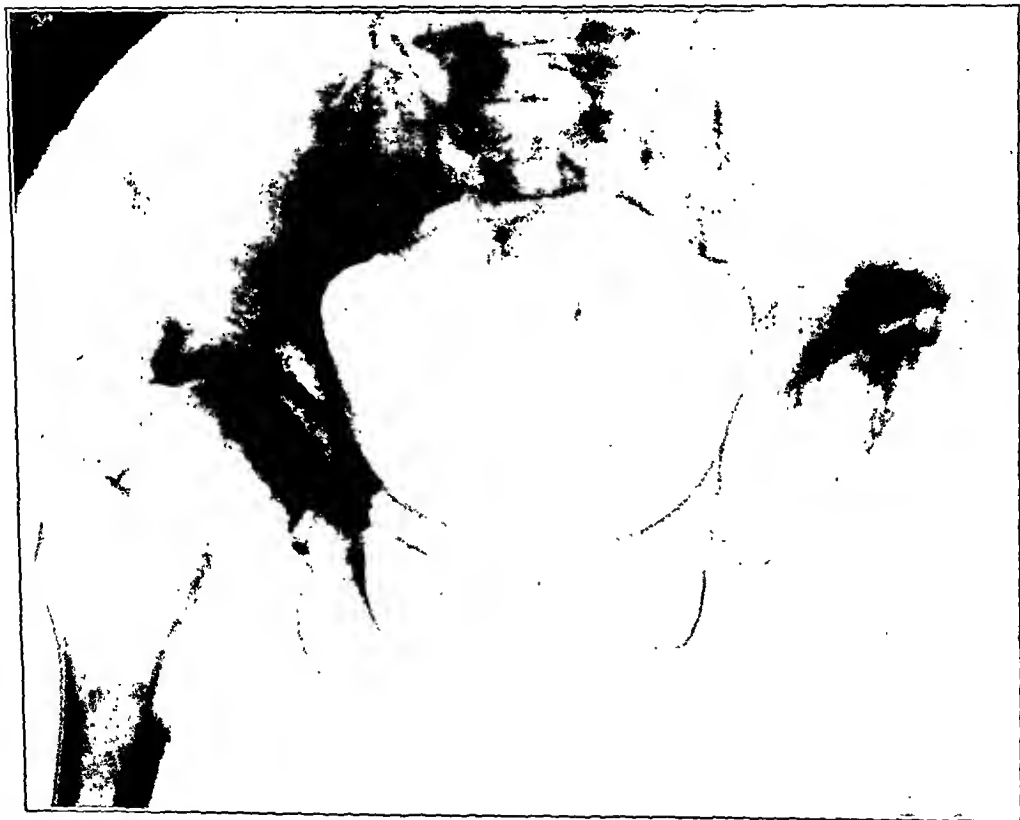


FIG. 142.—Excision of head and neck of femur for osteo-arthritis, complicating old ununited fracture: femur movable, but stabilized against rim of acetabulum (*Case 8*).

of recent origin, and therefore do not come within the scope of the present inquiry. I have carried out this operation in the last two years on four cases of hypertrophic villous synovitis. In all, the recurrent effusion and resulting disability was relieved, and a fair range of movement at the joint attained. It is, however, too early to estimate the ultimate value of the procedure in these cases.

This completes my survey of the subject as far as it can be pursued with the material at present available. I would admit that it is incomplete in

that it lacks a sufficient measure of crucial evidence. I hope, however, it may assist in clearing the ground. It should in some measure define the rôle which can be played by the surgeon in the treatment of certain cases of a common and disabling condition.

In concluding, I desire to acknowledge my great indebtedness for the numerous X rays I have had taken in the investigation of these cases. The Radiological Staff at St. Thomas's Hospital, and Dr. Tindal-Atkinson at Shepherd's Bush, have always cheerfully co-operated, however exacting my demands may have been.

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EXTRAVASATION OF URINE : WITH ESPECIAL REFERENCE TO PERI-URETHRAL ABSCESS.

By HAMILTON BAILEY and G. P. B. HUDDY, London.

DURING the fifteen years 1908-22, 107 cases of extravasation of urine from all causes were admitted into the London Hospital as set out in detail in the following table. There was no example of extravasation following ulceration around a urethral or ureteral calculus, nor was there a case of demonstrable perirenal extravasation following injury. As in more than half the cases, the extravasation followed a peri-urethral abscess, the latter will receive major consideration in this paper.

TABLE SHOWING THE SOURCE OF EXTRAVASATION AND THE
MORTALITY IN THE 107 CASES.

SOURCE OF THE EXTRAVASATION		NUMBER OF CASES	MORTALITY
			Per cent
Peri-urethral abscess .	..	65	44
Traumatic rupture of urethra	..	20	20
Injury to urinary bladder	..	13	92
Following suprapubic puncture	..	7	57
Extravasation in infancy	..	1	—
Following internal urethrotomy	..	1	—
		107	

EXTRAVASATION FOLLOWING PERI-URETHRAL ABSCESS.

This condition frequently complicates urethral stricture of long standing. But stricture does not appear to be the essential factor in causation, because the stenosis in some cases is not sufficient to cause complete retention of urine, and in a few cases stricture is excluded by urethroscopic examination. The determining factor in this catastrophe appears to be a virulent infection of the mucous membrane of the deep urethra extending to the peri-urethral tissues. Some authorities, recognizing this fact, have attributed the whole condition to a spreading cellulitis. Mr. Frank Kidd,⁶ however, in a series of cases, demonstrated that a fluid containing 2 per cent of urea could be isolated from the affected area.

Clinical Features.—These cases may be divided into three groups: (1) A swelling (peri-urethral abscess) has been present for a considerable period, but recently has increased in size and broken its confines; (2) Whilst straining at micturition, the patient experiences a 'sudden bursting'

in the perineum; (3) A perineal fistula (often of spontaneous origin, and following an abscess) has recently closed.

In severe and neglected cases the general symptoms may entirely mask the local condition. Thus, repeated rigors may be the leading feature of the case, or the patient is seen in delirium or coma.

In contradistinction to traumatic cases, the extravasation is not necessarily confined to those planes defined by the anatomist. It is not exceptional to find the cellular tissues of the thighs and peri-anal regions infiltrated. The probable explanation lies in the fact that the extravasated urine is infected, and suppuration breaks down anatomical barriers. Sir Benjamin Brodie stated that a black patch on the glans penis was a sign of fatal omen; of three such cases in this series, one recovered. It is generally noted that the extravasation proceeds more rapidly on one side than the other. Possibly this is due to the lateral position adopted by the patient in bed, or, as seems more probable, the urethral wall perforates upon the lateral aspect (see *Fig. 143*).

Differential Diagnosis.—The diagnosis is usually obvious.

General.—The severity of the general signs may, on occasion, mask the local condition; for instance, a case with repeated rigors has been confounded with malaria. Again, if the outstanding feature is delirium, a diagnosis of pneumonia or typhoid may be made, as recorded by Wolfer.

Local.—Turning to the local signs, difficulties in diagnosis are occasionally encountered; notably the scrotal œdema may be due to other causes, e.g., anasarca consequent upon a failing heart, or spreading cellulitis from an ischiorectal abscess. Each of these conditions, simulating extravasation, has been recently observed.

Mortality.—The mortality of this condition is exceedingly high. In this series 43 per cent died. The principal causes are septicæmia and uræmia; frequently the two go hand-in-hand.

Treatment.—The two great indications in treatment are to mitigate the blood infection and combat the uræmia. The first is carried out by making adequate incisions to relieve tension and admit of the free escape of urine and inflammatory products.

If, as is commonly the case, the patient exhibits uræmic symptoms, the stricture is probably a tight one, and the uræmia is due to retention reacting upon kidneys already seriously damaged by back-pressure, which has extended over a long period. In these cases it is of the utmost importance to relieve the condition by draining the bladder. It is not enough to make incisions into the inflamed area, or even to divide the stricture in addition. The bladder must be drained.

We will now examine the various methods which have been employed in dealing with this condition, and discuss their relative merits. They are: (1) *Multiple incisions only*; (2) *Multiple incisions combined with suprapubic cystotomy*; (3) *Multiple incisions combined with perineal cystotomy*.

1. **MULTIPLE INCISIONS, INCLUDING SIMPLE INCISION OF THE PERI-URETHRAL ABSCESS.**—For very many years this has been the method most generally adopted. The results are not always satisfactory, for the following reasons:—

In order to treat the condition radically, it is essential to relieve the retention at the earliest possible moment. Once the intra-urethral pressure behind the stricture is zero, the infected urine ceases to be extravasated, and attention can be directed to the cellulitis which invariably follows in its wake.

It might be argued that a peri-urethral abscess is an attempt by nature to perform external urethrotomy, and therefore by incision of the abscess 'the object of surgery' (i.e., to aid nature) is achieved. Unfortunately this simple measure is not always effective; moreover, in some cases there is very little pus or urine to evacuate.

In two recent cases it was noted that wide incision of the abscess did not open the urethra. The condition can best be illustrated by a diagram (Fig. 143). The effectiveness of this treatment is to a large extent governed by the size of the opening B. Since the opening is usually small and laterally placed, more thorough treatment is indicated. Simple incision should be reserved for desperate cases.

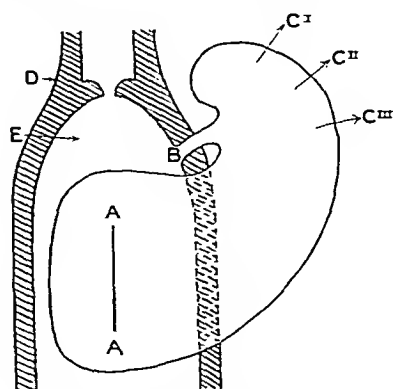


FIG. 143.—Diagram illustrating wide incision of abscess without opening urethra. A-A is an incision into the peri-urethral abscess which communicates with the urethra through a small lateral orifice (B) behind the stricture. C^IC^{II}C^{III} is that part of the abscess wall which has given way, and through which urine and pus are extravasating. D, Stricture. E, Dilated urethra.

2. MULTIPLE INCISIONS COMBINED WITH SUPRAPUBIC CYSTOTOMY.—This is strongly recommended by Wolfer. The method has the very obvious disadvantage that the cystotomy incision of necessity traverses the infected superficial planes, and thus infection may be carried to the cave of Retzius. If this occurs there is the danger of deep pelvic cellulitis, a very grave complication which proved fatal in one recent case under observation. Further, if the bladder is much distended and the patient uræmic, the immediate effect of a suprapubic cystotomy will be to depress the renal efficiency still further and thus very possibly hasten a fatal termination.

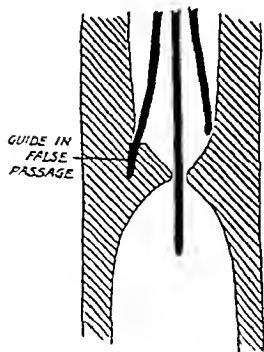


FIG. 144.—'Faggot' method of introduction of bougies.

3. MULTIPLE INCISIONS COMBINED WITH PERINEAL CYSTOTOMY.—This appears to be the method of choice, and therefore will be set out in detail.

Preliminary Urethroscopy to ascertain the site and estimate the calibre of the stricture if one is present.

The Urethra is Washed out, and novocain is instilled. The additional injection of methylene blue into the urethra in order that the mucous membrane can be more readily recognized, during the perineal stage of the operation has been found to be disappointing—

for necrotic tissues do not readily take up the stain.

An Attempt is made to pass a Bougie into the Bladder.—Great gentleness is exercised, for the urethra, being inflamed, may easily be perforated.

However, it is usually possible to pass a No. 3 or No. 4 French. In the absence of an instrument by which the bougie can be passed under direct vision, the 'faggot method' (*Fig. 144*) of introduction is of distinct value. The introduction of a guide simplifies the subsequent stages of the operation. If the bougie has been passed, it should be fixed in position. The patient is now anaesthetized. Spinal stovaine is indicated, for the uræmic condition of the patient renders a general anaesthetic dangerous.

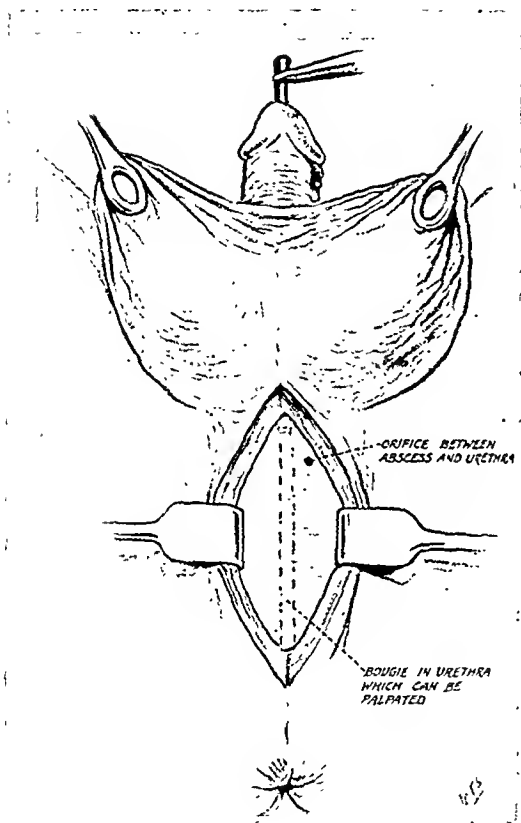


FIG. 145.—Showing position of bougie in the urethra.

a. If the bougie has failed to pass through the stricture: Wheelhouse's operation should be performed.

b. A bougie has been passed (which will be found possible in the majority of cases): The patient is now placed in the lithotomy position, and a sand-bag placed under the scrotum to exaggerate effectively this position. Lane's tissue forceps are clipped upon the most dependent part of the infiltrated serotum. These serve as scrotal retractors. By this method the serotum is pulled up and the perineum is clearly exposed to view. Towels having been arranged, an incision is made from the base of the serotum to within $\frac{1}{2}$ in. of the anal verge, keeping strictly to the middle line. The tissues in this region being extensively infiltrated, it is usual to find that one has to proceed to a depth of $\frac{3}{4}$ in. or more before the abscess is reached. Urine and pus then escape, usually under considerable pressure.

A finger is now passed into the wound, and the bougie within the urethra (*Fig. 145*) sought for by palpation. Retractors are then placed in either side of the wound, and the urethra is inspected. A head light is very useful at this stage. The breach in the continuity of the urethra can sometimes be seen. There was a hole admitting a probe in the lateral aspect of the necrotic urethra in two cases recently observed. The floor of the urethra is incised and the edges are retracted. The left index finger is passed into the dilated urethra, with the pulp against the bougie. The finger is thus guided into the bladder. A large coude catheter is then passed through the incision along the index finger into the bladder, and secured to one side of the wound with a stitch.

It is inadvisable to withdraw more than one pint of urine if the bladder is greatly distended. The residue is evacuated at intervals of four hours.

Drainage of the Cellular Tissues (Fig. 146).—The left forefinger is now passed through the perineal wound, upwards and outwards, clearing the crus penis, and made to protrude subcutaneously above and to the outer side of the symphysis pubis (*see Fig. 147*); the skin is then incised over the finger, and long blunt-nosed forceps retrace the path and emerge in the perineal wound. The jaws are opened and grasp a $\frac{1}{4}$ -in. drainage tube, previously perforated, which is then pulled up and fixed by a stitch. This procedure is repeated on the opposite side.

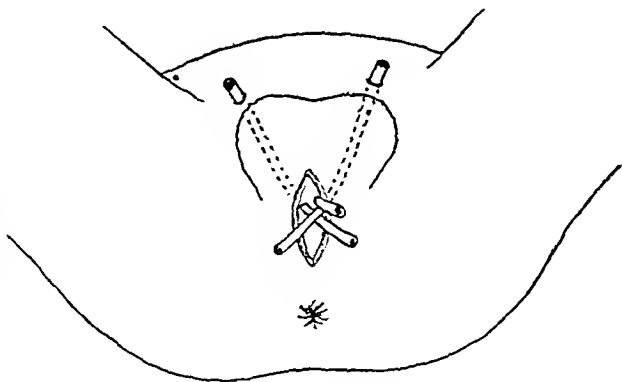


FIG. 146.—Method of drainage (after Hartmann).

Incisions into the Infiltrated Tissues.—In contrast to the older methods,

fewer but larger incisions are recommended. There is a tendency, on account of the infiltration, for the incisions to be too superficial; they must be of sufficient depth to penetrate the limiting fasciæ.

Injections of Hydrogen Peroxide.—It has been shown that anaerobic organisms are largely responsible for the spreading cellulitis in these cases (Jungano). As oxygen is inimical to these organisms, hydrogen peroxide is injected into the subcutaneous tissues around the incisions by means of a Crile's anoci-association syringe, fitted with an angular needle.

Dressings.—Moist dressings of esul are applied over the abdominal wall, perineum, and serotum; these are covered over by packing towels, and the whole is secured by a T-shaped bandage.

After-treatment.—During the first twenty-four hours the patient is encouraged to drink as much fluid as possible; rigors are usual during this



FIG. 147.—Patient convalescent from peri-urethral abscess with extravasation. A, A. Site of subcutaneous tubes referred to in text; B. A long incision into the infiltrated tissues.

period, and are most successfully combated by hot gin and quinine. The catheter is removed at the end of forty-eight hours. Every four hours all the wounds are irrigated with eusol through a Higginson's syringe, after hydrogen peroxide has been instilled for a few minutes. At the fourth day shortening of the tubes should be commenced. As soon as the general condition permits, sitz baths are instituted.

Drugs.—Acid sodium phosphate and hexamine, combined with tincture of hyoseyamus, are given in liberal doses.

Residual Abscess.—This is frequently seen in the flank just above the anterior superior iliac spine. Under gas anæsthetic the abscess should be freely opened.

When the infection has subsided, which is usually in about three to four weeks, the treatment of the perineal fistula should receive attention. If the stricture has not been divided, an internal urethrotomy with insertion of a catheter is an effective method of dealing with the condition and hastening the closure of the wound. Occasionally it may be possible simply to dilate the stricture with bougies.

The patient should not be discharged until the fistula is closed, and the stricture must then be dilated regularly.

EXTRAVASATION FROM OTHER CAUSES.

Ruptured Urethra.—Under the title of ruptured urethra there are included two entirely distinct clinical entities:—

a. The first consists of the classical cases due to a fall astride and resulting in a complete or incomplete tear of the bulbous urethra. Of 47 cases of ruptured urethra of this type admitted to the London Hospital during the period under consideration, only 11 were complicated by extravasation of urine.

b. This comprises those cases in which the urethra is torn above the anterior triangular ligament—the morphological bony pelvis. There were 9 examples in this series. This variety is a direct complication of fractured pelvis, and the extravasation occurs into the cave of Retzius.

The differential diagnosis between an intrapelvic rupture of the urethra and an extraperitoneal tear of the bladder is usually a matter of profound difficulty. The diagnosis in the majority of cases is uncertain until a suprapubic incision has been made. Even then some difficulty may be encountered in determining the exact site of the lesion amidst the blood-stained effusion. There is, however, one guiding rule: if the bladder is even moderately distended, the lesion must be situated below the vesical sphincter.

Injury to the Urinary Bladder.—Extraperitoneal, 5; Intraperitoneal, 4; Extra- and intraperitoneal, 4; Total, 13. Nine of these followed an abdominal contusion or a fractured pelvis; two were consequent upon catheterization and irrigation of a dilated atrophic bladder secondary to enlarged prostate: at necropsy the bladder showed a perforation at the fundus in both instances. There was one example of extravasation following an injury to the bladder during an operation for the relief of strangulated

femoral hernia. Lastly, there was a case following normal parturition, and this is so exceptional as to warrant some reference to the details.

A primipara, age 28, was confined five days previously and delivered, without forceps, of a healthy child. On admission the condition was desperate. There was great abdominal distention and faecal vomiting. Laparotomy was immediately performed, the peritoneal cavity being drained through a sub-umbilical incision. The patient died a few hours later.

A necropsy showed general peritonitis due to extra- and intraperitoneal tears of the posterior part of the fundus of the bladder: the surrounding mucosa was injected and sloughing. There was a uterine tear limited to the cervix.

Extravasation following Suprapubic Puncture.—Seven cases followed aspiration of the bladder for relief of acute retention.

At operation, in two of the most recent examples of extravasation from this cause, a puncture of the vesical wall through which urine was escaping could be clearly seen. Therefore simple suprapubic puncture is a method not devoid of danger. It is obvious that, unless the cause of the retention has been removed before the bladder again becomes tense, there is always a risk of leakage occurring at the site of the puncture. If urine thus extravasated is infected, pelvic cellulitis must ensue. The introduction of a catheter through a suprapubic trocar of suitable dimensions obviates this complication, for the intravesical pressure remains minimal. There was no case of extravasation in this series following the latter method.

Extravasation of Urine in Infancy.—In this series there is but a solitary example of this very rare condition.

A male, age 6 weeks, was admitted with acute retention and extravasation into the serotum and far up the abdominal wall. Temperature 104°. External urethrotomy was performed, and combined with multiple incisions. The child died.

A necropsy showed a purulent external urethrotomy wound leading into a lacerated urethra and communicating with a peri-urethral abscess in front of the triangular ligament. There was gangrenous cellulitis of penis, serotum, and cave of Retzius, and an abscess in the right lobe of the prostate. The meatus was of normal calibre, and there was no phimosis. The bladder was distended and hypertrophied, and the kidneys showed parenchymatous degeneration and pin-head abscesses. Slight seropurulent leptomeningitis in the Sylvian fissure and over the right temporal lobe was associated with cerebral softening and embolism of the right cerebral artery.

The cause of the extravasation in this extremely interesting condition was obscured at necropsy by the purulent external urethrotomy wound, which precluded the possibility of a precise diagnosis. As there was no evidence of meatal stenosis or of urethral calculus, it seems probable that this was a case of congenital stricture of the deep urethra.

Extravasation following Internal Urethrotomy.—This is a very rare complication of the operation. The danger would appear to lie in the passage of the pilot into a false passage.

A greengrocer, age 53, had suffered for some months with dysuria, culminating in strangury: for twenty-four hours before admission he had absolute retention, which was relieved by a hot bath. Four days later, under gas and novocain, an internal urethrotomy was performed, and was followed two days later by a typical extravasation. The treatment consisted of multiple incisions and the insertion of a silver catheter. The patient sank, and died in coma.

Necropsy revealed cellulitis involving the penis, scrotum, and abdominal wall. There was a stricture 1.7 cm. long in the bulbous urethra. A false passage led into a purulent sinus at the side of the stricture, and extension of the sinus passed upwards along the corpora cavernosa and communicated with a large abscess of the left lobe of the prostate.

After completing the foregoing, and being desirous of finding the exact source of Brodie's observation that a black patch on the glans penis was a harbinger of death (which Mansell Moullin referred to in his text-book of 1891), we consulted the works of Sir Benjamin Brodie. So full of interest are Brodie's observations on this subject that we beg leave to quote verbatim from his *Diseases of the Urinary Organs*, 4th edition, 1849.

"Sometimes a black spot is seen on the glans penis: an almost fatal symptom, indicating that the whole of the corpus spongiosum is infiltrated with urine. . . .

"But the danger from the effusion of urine is not the same in all cases. In the majority the effusion takes place in front of the triangular fascia of the perineum, or else the fascia gives way and allows the urine to pass forward to the superficial parts instead of penetrating to the deep-seated; and under these circumstances life may generally be preserved by the prompt interference of the surgeon. In a very few cases the effusion extends into the loose cellular membrane which surrounds the bladder, and the patient's condition is hopeless.

"Where the urethra has given way behind the stricture, and the urine has become effused into the cellular texture, very prompt and vigorous measures are necessary: delay is fatal. I remember the time when five out of six of the patients in whom this mischief took place perished; but now, from the more active treatment employed under the hands of a well-informed surgeon, the great majority recover.

"I have already mentioned that the effusion of the urine is followed by a relaxation of the stricture. You will probably now be able to introduce a catgut, or some other bougie (a catgut one is to be preferred), through the stricture into the bladder. If you can do so, it is so much the better. Introduce the bougie; let the patient be held in the position in which you would place him for lithotomy; make an incision in the perineum; feel for the catgut bougie, and make an incision on it; of course, you make an opening in the urethra. Through this opening, the catgut bougie serving you as a director, introduce a short gum catheter from the wound in the perineum into the bladder. You will generally find, although the effusion of urine has taken place, that there is still a large quantity of urine left in the bladder. Of course, it is drawn off by the catheter, and the bladder is emptied. Allow the catheter, however, to remain in the wound and in the bladder. Then make extensive scarifications or incisions through the skin, wherever the urine has been effused underneath, and let these incisions extend to the sloughs of the cellular membrane."

Thus, over three-quarters of a century ago Brodie devised a technique which reduced the mortality of this condition from "five out of six" to "a recovery of the majority".

Under modern condition and advantages, would not the adoption of the

basic principles of the great pre-Listerian master improve the prognosis of this, the commonest variety of urinary extravasation?

We beg to record our thanks to the surgeons of the London Hospital, and particularly to the director of the Genito-Urinary Department—Mr. Hugh Lett—for his invaluable help in the preparation of this article.

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THE MEDIAN EXTRAPERITONEAL ROUTE TO THE URETER.

By K. W. MONSARRAT, LIVERPOOL.

THE routes commonly employed in ureteral lithotomy are: (1) The lumbar; (2) The inguinal; (3) The transperitoneal. It may be confidently stated that the sacral, perineal, vaginal, and rectal routes are not now followed.

1. The lumbar route has a limited use in those cases where a calculus is lodged in the renal end of the ureter, and the incision and subsequent steps of the operation are as for a pyelotomy.

2. The inguinal operation is either a muscle-cutting or a muscle-splitting operation or a combination of these. It gives excellent access to the calculus which is arrested about the pelvic brim, but indifferent access to one in the depth of the pelvis. If a calculus cannot be milked upwards, the suture of the ureteral wound is difficult.

3. For the transperitoneal route the advantage of palpation of the opposite kidney and ureter was claimed, but no longer carries weight. While the route has the advantage of being short and direct, it is generally felt by surgeons to be undesirable. It inevitably adds to post-operative discomfort, and is attended by some risk of infection.

I am aware of the combination of a transperitoneal exploration and an extraperitoneal exposure, but have no experience of its usefulness.

I wish to testify to the great technical advantages of a median suprapubic incision down to the peritoneum, followed by extraperitoneal exposure of the ureter by peritoneal displacement. The steps of the operation are as follows: An incision is made from umbilicus to pubis, the aponeurosis is divided to the same extent, the recti are bluntly separated, and the extraperitoneal plane is reached. If the calculus is in the right ureter, separation of the peritoneum proceeds on that side towards the iliac fossa, continued round the pelvic basin until the common iliac bifurcation is reached, when the ureter is found and comes off the vessel with the peritoneum. A large broad-bladed retractor is then inserted, and displaces inwards the peritoneal sac and its contents. The ureter is then traced to the point of impaction of the calculus, and this is displaced as may be thought desirable, and removed. After suture of the ureteral wound a stab wound is made through the abdominal wall in the right iliac fossa through which a half tube passes towards the site of the ureteral mend. Retractors are then removed, the peritoneum falls back into place, and the median wound is sutured throughout its length.

Apart from a somewhat similar procedure for cases of bladder resection, I first employed this method for the removal of a ureteral stone in the following case: On Nov. 11, 1920, I removed an adenomatous prostate by

suprapubic enucleation from a patient 57 years of age. He was a healthy man of powerful physique, weighing some 16 stone. On Dec. 6, 1921, I removed a calculus from his bladder and another from the lower end of his left ureter. The bladder was reopened through his suprapubic scar and the vesical calculus removed. By peritoneal stripping between bladder and left pelvic wall the ureter was exposed and the calculus here removed. I had expected to be able to remove it through the left ureteral orifice from inside the bladder, but this proved impossible. He left the home healed four and a half weeks later.

I have used the same procedure on many occasions since then, the last example being the following: A male patient, age 32, an engineer by occupation, was admitted to the Northern Hospital on Feb. 16, 1924, complaining of blood in the water and pain in the right side. He stated that the first attack of pain occurred in August, 1921, and that he then noticed blood in the urine. He had had several attacks of the same kind since.

Radiographic report: "There is a shadow in the pelvic region on the right side in the line of the ureter which may be a calculus, but its long axis is not in the direction of the ureter." A fair number of red blood-cells were present in the centrifugalized urine deposit. The right kidney was not palpable. Although the radiologist's report was not definite, the diagnosis of ureteral calculus was considered positive.

On Feb. 26 an incision was made from umbilicus to pubis. The extraperitoneal plane was opened up below, and the peritoneum stripped from the right pelvic wall until the ureter was reached. The calculus was easily found and displaced upwards, the ureter was incised, and the calculus removed. The ureter was explored with catheter upwards and downwards, and the wound then sutured with catgut 000. A stab wound was made through the abdominal wall an inch inside the anterior superior spine, and a half tube passed to the site of the ureteral wound. The retractors were then removed, and the suprapubic wound was sutured with interrupted catgut stitches and supporting through-and-through stitches of silkworm gut.

The drainage tube was removed in forty-eight hours, the dressing being dry. He was discharged from hospital eighteen days after operation.

VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

THE CLINIC OF PIERRE DUVAL, PARIS.

A SMALL group of surgeons visited the clinic of Professor Pierre Duval in Paris recently. This is a record of the impression made upon them of what they saw there. The time spent in the clinic was brief, so that the insight into the activities engaged in by the workers of the institution was necessarily limited. L'Hôpital de Vaugirard contains nearly 200 beds, all of which are under the direction of the Professor. We have no entity corresponding to it in this country; it is not comparable with the surgical division of one of our hospitals, as will be seen from what follows: it is described as a 'clinique thérapeutique chirurgicale', a quite untranslatable expression, as it implies a definite unit such as is unknown over here. The staff is a large one. There are an assistant professor and two assistant surgeons (chefs de clinique chirurgien), one physician, two foreign surgical assistants, three surgical internes, and ten externes. These are members of the ordinary surgical service; and in addition there are a urologist, gynaecologist, oto-rhino-laryngologist, oculist, dentist, and two radiographers, whilst in the special department for gastro-enterology there are three physicians. There are two chemical laboratories and also a combined pathological and bacteriological laboratory, all of which have their own adequate staffs.

The hospital receives a large grant from public funds, and the Professor is allowed great latitude, not only in the expenditure of this money, but in the plan of administration of his clinic. There is plenty of room for individual expression, and it seems the object of the State to foster originality by freeing the Professor from the hampering shackles of State control. An outstanding feature of the clinic is a vitality of outlook and an all-pervading spirit of investigation. Research takes a more prominent part than undergraduate teaching, though this is not lost sight of by any means. Professor Duval holds that prolonged undergraduate teaching is mentally sterilizing, and that after a number of years only advanced teaching should be required of the head of a large clinic. He therefore relegates undergraduate teaching to his staff, confining himself to post-graduate and advanced instruction. At present he is concerned particularly with diseases of the digestive tract, and it is interesting to see how the problems arising out of this study are tackled. The physicians, radiographers, and pathologists all see the patients clinically with him, whilst they all witness the radiographic examination and the operations performed, should such be decided upon. No case is radiographed without the Professor being present. In this clinic there is no such thing as one

member of the team falling behind in his knowledge of his colleagues' special departments. Nothing but good can come from such a system. It makes co-ordination a real thing, but it is necessarily exacting in the time and energy demanded from all the members of the clinic.

A great deal of research is being carried on in the radiographic appearances of affections of the duodenum and gall-bladder. A wonderful selection of photographs was exhibited. Pierre Duval claims that he can diagnose 40 per cent of gall-stones by direct radiography, and another 40 per cent from indirect radiographic evidence. From the perfection of technique shown to the visitors, this is easily credible. M. B  cl  re, the radiographer, has

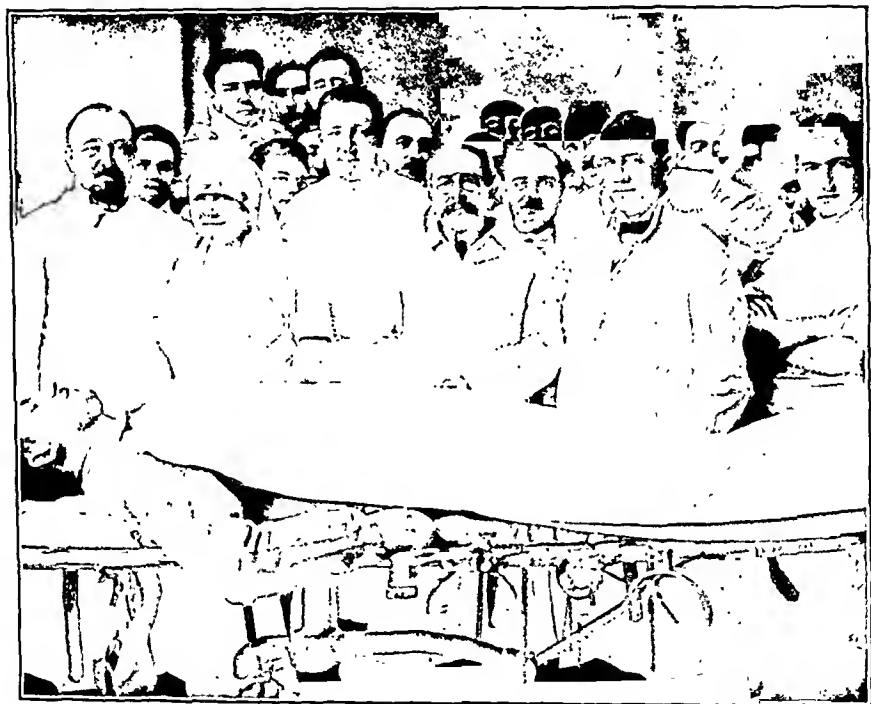


FIG. 148.

invented a very ingenious apparatus by which a number of films of about half-plate size can be exposed in rapid succession, up to thirty, in the minute. The films in separate holders are loaded in the apparatus used for screening in the erect position. The opaque meal is watched as it passes into the duodenum, and at any moment a photograph can be taken without moving either the patient or screen. In studying the duodenum and gall-bladder great use is made of lateral views. Some radiographs of chronic duodenal ileus due to obstruction by the superior mesenteric artery were shown, and it was explained how such obstruction, present in the erect position, is relieved when the patient lies prone. The many points by which gall-stones render

their presence evident were gone into, such as the movement of the shadows with change of position of the patient, their situation in profile view in relation to the spine, the distortion of or dragging on the duodenum.

Some interesting skiagrams illustrating the surgical treatment of Pott's fracture were demonstrated, and the method employed was explained. Immediately the patient is admitted, a spinal anæsthetic is given and reduction attempted on the X-ray couch. Should it be successful, a plaster cast is applied; but if all efforts are ineffective, operation is proceeded with. It consists in the fixation of the fragments in proper position by means of screws. An original method of photographing the elbow or knee-joint in a flexed position was demonstrated. The limb is bent over an earthenware jar, round which is wrapped the X-ray film. The tube, by a clever removable projection apparatus, is centred accurately over the joint space, and the skiagram taken. Photographs were exhibited which clearly proved that in this way the joint space in the knee appears much larger than by the usual method, whilst by this technique alone can certain loose bodies in the joint be detected.

A tour of the laboratories was made, and in the lecture room was seen a simple and cheap apparatus for projecting diagrams and solid objects on the screen (episcope).

The next day several operations were witnessed. The operation theatre itself is a large room with walls green to diminish eye-strain. It contains literally nothing beyond an operation table, anæsthetist's stool, anæsthetist's table, and instrument and dressing tables; not even a gallery for spectators. There are no rows of bottles on shelves, or apparatus of any other kind. The walls are perfectly smooth. The actual operative technique is interesting from many points of view. For abdominal work, local and conduction anæsthesia are not used. The Professor has found the incidence of lung complications after these methods as great as, if not greater than, after inhalation anæsthesia. The Clover apparatus is used for the administration of ether. The operator and his two assistants wash and dress in a neighbouring room. The patient is strapped to the table. The instruments in a metal container are sterilized by dry heat, a separate set for each case. They are placed in their container on the operator's table. He selects and handles his own instruments, whilst ligatures are looked after by his assistant, who has them on his own table. Behind the instruments are placed the drums containing the dressings; their completely detachable lids which envelop the whole drum are removed by the sister. The operator helps himself to towels and swabs. No nurse is washed up to take part in the operation. The nursing staff simply convey to the operator instruments or dressings in sterilized containers. Non-absorbable suture material is used for most intestinal anastomoses and for the stomach. Catgut is only used within the abdomen for septic cases. It is employed for suturing the muscles of the abdominal wall, but not for the peritoneum. Access to the operation area in the abdomen is gained by the free use of large retractors. Thus, when operating upon the upper abdomen, a large Doyen retractor is inserted in the upper angle of the wound. All sewing is done by means of Reverdin needles of different sizes: this makes for rapid work with a perfectly trained assistant.

The first operation was for a duodenal ulcer situated at some distance from the pylorus. A posterior gastrojejunostomy was performed without clamps, and the pylorus closed by a single encircling suture. M. Duval says he has met with but one gastrojejunal ulcer, and attributes this to the fact that he does not use clamps.

The second patient had a number of adhesions around the duodenum, and was described as being a case of simple periduodenitis due to disease of the gall-bladder without stones. The adhesions were separated and cholecystectomy performed. The gall-bladder was removed from the neck towards the fundus. No drainage was provided. The operator explained that only in 10 per cent of cases was it possible to close the abdomen without drainage, the ability to make a proper peritoneal covering for the stump of the cystic duct determining the possibility of doing this.

The third case had been diagnosed as one of simple periduodenitis, but it proved to be chronic duodenal ileus. This made the thirty-second case of the kind upon whom the Professor had operated. A duodenojejunostomy was performed.

The last case was gynæcological in nature, an ectopic gestation. The affected tube was removed. Catgut was used in the abdomen in this patient.

The speed at which technique is carried out in this clinic can be gathered from the fact that these four operations were performed in two hours and ten minutes, although there were considerable intervals between them, the same anaesthetist acting in each case. The character of the operating was to perform the essential steps in the shortest possible time and return the patient to bed, neglecting certain niceties of technique upon which stress is laid by some surgeons. The theatre was kept unusually hot, with the idea apparently of diminishing the risk of subsequent bronchial affections. For the first few days after the operation the patients are kept in separate cubicles before being returned to the general wards. The perfection of organization of the whole hospital is illustrated by a small point. Each patient has an electric bell-push. Should he ring for help a red lamp glows outside his cubicle, and remains alight until extinguished by the answering nurse.

One came away from the clinic impressed with the dynamic atmosphere pervading it, with a feeling that advance in knowledge must proceed from such a system, and convinced of the essentially sound policy adopted by the State of granting an unusual liberty of action to its professors, in the belief that only in this way can real progress be made.

*SHORT NOTES OF
RARE OR OBSCURE CASES*

**AN OBSCURE CASE DUE TO CALCULUS IN THE PELVIS
OF AN ECTOPIC KIDNEY.**

BY HUGH REID, LIVERPOOL.

THE case was under the care of Mr. Thelwall Thomas at the Royal Infirmary, Liverpool, and seen by the writer as surgical registrar. The patient is a male, age 28.

HISTORY.—He gave a history of attacks of pain in the left lower lumbar region for the last three years. This was accompanied by frequency of micturition and the passage of dark-coloured urine. Lately the attacks had been becoming more frequent and severe, and the intervals of relief shorter. The pain was of a cutting nature, starting in the left lumbosacral region and shooting towards the groin. It lasted about twelve hours, and was followed by what the patient thought was blood in the urine. At the same time he suffered from pain in the suprapubic region, which passed some way down the penis.

ON ADMISSION, in November, 1923, the man looked healthy. He lay easily in bed; the abdomen moved normally with respiration; no abnormal swellings, or rigidity or tenderness, were detected. The urine showed a few blood-cells, but no crystals. Pus-cells and epithelial cells were seen in direct films. Staphylococci were grown on culture.

The X-ray report (by Dr. R. E. Roberts) was: "Stone in bladder" (*see Fig. 149*).

On Nov. 29 Mr. Thomas passed a lithotrite, but no stone was felt. A sound was then passed and a careful exploration of the bladder made, without result. A cystoscope was substituted for the sound, but nothing abnormal was seen in the bladder. The patient was sent away for another skiagram.

On Dec. 4 a further X-ray report stated: "Same shadow in practically the same place, but rotated on its axis. The only other two possibilities are (1) calcareous gland of unusual appearance, or (2) stone in a much distorted ureter. The shadow is not so clear cut as one would expect in the case of a ureter stone. The whole thing is atypical".

On Dec. 6 cystoscopy showed pus coming from the left ureteral orifice. The right ureteral orifice was normal. From this it was decided that the condition was due to stone low down in a much dilated ureter.

OPERATION, Dec. 12, by Mr. Thomas.—Split muscle incision over left iliac fossa. Ureter not found. The kidney was then discovered to be placed

entirely below the brim of the bony pelvis. The organ could not be brought out of its bed through the wound. Renal vessels were arising from bifurcation of common iliac artery. Part of the kidney substance and the renal pelvis were incised, and a typical calcium oxalate stone was removed. The renal pelvis was sutured, and the wound closed with split rubber drainage tube down to the kidney.

On Dec. 26 the patient was discharged after a normal convalescence. The specimen measured $1\frac{1}{16}$ in. \times $\frac{1}{8}$ in., and weighed 94 gr.; it was oval in



FIG. 149.—Calculus in pelvis of ectopic kidney.

shape, pale brownish yellow in colour, and the surface was covered by sharp glistening crystals.

A review of the literature of ectopic kidneys is given by Dorland¹ in 1911, and nineteen cases are reported by Judd² in 1919, in one of which stones in the pelvis and calices of a pelvic kidney were discovered.

REFERENCES.

- ¹ DORLAND, W. A. N., "A Consideration of Renal Anomalies; with the presentation of Two Unique Cases", *Surg. Gynecol. and Obst.*, 1911, xiii, 303.
² JUDD, E. S., and HARRINGTON, S. W., "Ectopic or Pelvic Kidney", *Ibid.*, 1919, xxxviii, 446.

AN ABNORMAL FIRST RIB FORMING A SUPRACLAVICULAR TUMOUR.

BY C. HAMILTON WHITEFORD, PLYMOUTH.

THE patient is a girl, age $3\frac{1}{4}$ years. The mother first noticed a 'lump' in the right side of the neck when the child was two years old. One inch above the centre of the right clavicle there is a tumour which projects the skin. On palpation there is found, immediately beneath the skin, a curved, fixed body



FIG. 150.—Girl, age $3\frac{1}{4}$, with an abnormal first rib. A, Curved lead wire to mark projection beneath skin.

of the shape and consistency of a rib. There is no pulsation, and nothing resembling blood-vessels or nerves can be felt between the tumour and the skin. There are no symptoms, and the shoulder movements are normal. No abnormality is visible or palpable in the left side of the neck. The skiagram (taken with the child lying on her back on the plate) shows that the first dorsal vertebra has, on its left side, a normal

first rib, but on its right side a rib which appears as a horizontal straight bone $1\frac{1}{2}$ inches in length (*Fig. 150*). Actually this rib is much longer, and curved from behind forwards. A palpable and visible supraclavicular tumour formed by a first dorsal rib appears to be a rare abnormality. The mother, who had been urged at a hospital to have the bone removed at once, "to prevent paralysis of the arm", was advised that it would be time enough to think of an operation if pain or weakness should occur in the arm, and that such symptoms might never appear.

ACUTE COLIC INTUSSUSCEPTION IN A CHILD.

BY W. E. TANNER, LONDON.

THE patient, a girl, age 2 years and 9 months, was admitted to hospital on March 30, 1924. She was an artificially-fed baby, and had pneumonia when one year old. Her general health was good, and she is a strong, healthy child.

At 9 a.m. on March 27 she fell down eight stairs. She was apparently uninjured, and the bowels were open normally during the course of the

morning. She was quite well until 1 p.m., when she refused her dinner and complained of pain in the lower abdomen. She was put to bed and went to sleep for half an hour. She woke up screaming, with violent abdominal pain which lasted for a quarter of an hour, but no vomiting. The pain continued for the rest of the day, with short periods of quiet. During the night the pain continued, and she kept asking for the chamber, but with no result. Tenesmus was marked, and the legs were drawn up on the abdomen.

On March 28 she seemed better, but was cross, and demanded to be nursed all day. The bowels were not open, and in the evening she had more pain and was taken to a doctor. She was given medicine, following which she vomited, and the mother said there was blood in the vomit. She refused food and drink all day, and at night the pain became much worse, with tenesmus. A little blood and mucus was passed. On March 29 the patient was easier in the morning but drowsy all day. The pain was not so severe, and there were long intervals of freedom. The bowels were not opened, and at night the pain became worse, with frequent vomiting and tenesmus. On March 30 the pain was worse in the morning, and not relieved by a hot bath. The mother was frightened by a 'peculiar look in the child's eyes', and, after consulting her doctor, brought the child to hospital.

On admission, temperature was 97°, pulse 90, respirations 30. The child looked ill and drawn. There was marked general distention of the abdomen, and a hard, sausage-like tumour was felt in the left iliac fossa. On rectal examination, an intussusception could be felt, just within reach of the finger. On withdrawing the finger from the rectum, a gush of blood and mucus followed.

Operation was performed on March 30 at 2.30 p.m.: right paramedian laparotomy. Blood-stained fluid escaped from the peritoneal cavity. The intussusception was reduced by gentle pressure from below. On reduction it was seen that it was colic, and had commenced at the splenic flexure of the colon. No polyp or other abnormality was found to account for its occurrence. The pelvic colon was elongated, and the descending colon had a complete mesentery and was freely movable. The wound was closed in layers. The patient made an uninterrupted recovery.

Acute colic intussusception is comparatively rare. In Perrin and Lindsay's¹ series it formed 5.6 per cent of 335 cases. All the idiopathic cases occurred before the seventh year. In my own series of 30, this is the first example of an acute colic intussusception. The length of the history, seventy-four hours, is of interest. In Perrin and Lindsay's series the average length was thirty-three hours. Was the accident responsible for the sequence of events? This appears to have been as follows: Elongation and distention of the pelvic and descending colon; spasm of the distal half of the transverse colon as far as the splenic flexure; irregular peristalsis; formation of an intussusception at the splenic flexure, a fixed portion of the bowel, which may have been damaged as a result of the fall downstairs.

REFERENCE.

¹ PERRIN and LINDSAY, *Brit. Jour. Surg.*, 1921, ix, 46.

REVIEWS AND NOTICES OF BOOKS.

Chronic Intestinal Stasis (Arbuthnot Lane's Disease): A Radiological Study.

By ALFRED C. JORDAN, C.B.E., M.D. (Camb.), M.R.C.P. (Lond.), Corresponding Foreign Member, Belgian Royal Academy of Medicine. 4to. Pp. 230 + xi, illustrated. 1923. London: Oxford Medical Publications. 25s. net.

CHRONIC intestinal stasis is here dealt with partly from the point of view of the radiologist, though the subject matter is by no means confined to radiological considerations. The author outlines the views held by Sir W. Arbuthnot Lane on the alimentary tract, and attempts to correlate them with the X-ray appearances of the opaque meal and enema in health and disease; the result is not always a happy one, as he frequently makes dogmatic statements upon subjects on which even his extensive but specialized experience can hardly support an authoritative opinion. It is, in fact, impossible to apply the ordinary standards of criticism to this work, since it forms, not so much a text-book, as a résumé of the theories adopted by one school of thought. Much of the subject matter of the book has appeared in article form in various medical journals since 1911; and the impression is forced upon the reader conversant with these publications that Dr. Jordan has learnt but little from the great radiological experience which he has undoubtedly enjoyed during the intervening years. In nearly every chapter which deals with the radiological aspect of his subject will be found early observations on the normal and abnormal appearances which are of the greatest interest and value; but these are generally followed by deductions to which the later experience of other workers lends but little support. A particularly unfortunate chapter is that on the pelvic colon: the author here enumerates cases of disseminated sclerosis, epilepsy, fibroid plithisis, Dupuytren's contraction, etc., in which elongation of the pelvic colon was present; and the reader is invited to accept as a fact that the colonic abnormality provides the causal factor in the production of these lesions, no attempt whatsoever being made to advance proofs of these startling assertions.

A chapter on the treatment of stasis is of considerable interest. The author lays great stress on the value of the Curtis belt, combined with the administration of liquid paraffin, belladonna, and colloidal kaolin, and emphasizes the importance of correct diet. He considers that surgical intervention is only required for rectifying the secondary consequences of stasis, and in those cases where the large bowel is diseased beyond repair.

Selections from the Works of Ambroise Paré: With Short Biography and Notes. By DOROTHEA WALEY SINGER. Crown 8vo. Pp. 246, illustrated. Medical Classics Series. 1924. London: John Bale, Sons & Danielsson Ltd. 12s. 6d. net.

ALL lovers of the classics of medicine have every reason to be thankful to Mrs. Singer. She has added a very delightful book on Ambroise Paré to the series of Classics of Medicine edited by her distinguished husband. Of course, classics of medicine may be dull, just as all classics may be dull; but Paré is of unflinching

interest. His life and his work and his character will always attraet the minds and the hearts of good judges of mankind. He lived in times which were full of passion and adventure; he was surgeon to four Kings of France, and to a host of the nobility, and gentry, and poor folk; his adventures in practice, especially in military service, and his discoveries and theories, will never be dull. Besides, his pleasant character, his humour, his love of his country, his enjoyment of the evident privileges of his existence, from good wine up to religion, stand out as clearly as any of his adventures and theories. Altogether he was a most lovable man.

It must have been hard work for Mrs. Singer to resist the temptation to rhapsodize over him: but she has done well to give more attention to his writings than to his home life, his services to the Royal Family and the Court, and so forth. He attended each of that brood of sons whom Catherine de Medici bore to Henri II, and he "held his cup straight", Huguenot though he was, through all the intricacies of that Court. Mrs. Singer wisely says that the question of Paré's religion never has been, and probably never can be, entirely decided: "for the truth is that he was neither fully Catholic nor fully Huguenot, but a devout and simple-hearted lover of God and man, who went his way and did his work according to such light as was given him, avoiding, as far as was possible, in those evil days, all the hatreds and envies that the name of religion inspired".

Only two criticisms of this book are possible. Mrs. Singer has kept the old-world spelling of Johnson's translation of Paré's works: perhaps she has done well; but it is hard to see why we have modernized Shakespeare if we are to be held down to the Elizabethan spelling of Johnson. The only other criticism is in regret that she has not used the portrait of Paré which Le Paulmier published in his *Life of Paré*. It is a charming portrait. Anyhow, here is a good book, worthy of buying and studying. It is a great pity that the old Harveian and Hunterian Orations are tied down to the pious commemoration of two men and no more. Long ago the original spirit of these Orations flickered out. The authorities ought to arrange for the praising of famous men in order of time. Ambroise Paré, most certainly, ought to be recalled to the gratitude of all our profession, and of all men who love a good life well lived. Meanwhile, let us congratulate Mrs. Singer on this excellent book about him.

The Treatment of Fractures in General Practice. By C. MAX PAGE, D.S.O., M.S., F.R.C.S., Senior Surgeon to Out-patients, St. Thomas's Hospital, and W. ROWLEY BRISTOW, M.B., B.S., F.R.C.S., Surgeon to the Orthopædic Department, St. Thomas's Hospital. Demy 8vo. Pp. 239 + xi, illustrated. 1923. London: Oxford Medical Publications. 12s. 6d. net.

This handbook sets out to assist the general practitioner in the treatment of fractures, and in our opinion fulfils its object. The chapters dealing with general principles of treatment are clear, and in most cases give sufficient detail to be of practical value. A book emanating from St. Thomas's Hospital is certain to advocate the employment of plaster-of-Paris more generally than would be the custom of many surgeons, but even those who do not favour the use of plaster could take no great exception to its employment as advocated in this volume. In this connection we doubt whether the single plaster-of-Paris spica as depicted on page 150 would maintain abduction of the limb, as in our experience tilting of the pelvis will occur unless both thighs are held in plaster. In some instances it is our opinion that the authors are sanguine as to the results likely to be obtained from splint treatment. As an instance, the advice given for the treatment of fractures of the upper third of the femur will serve: it has not been our experience that such fractures can be adequately reduced by such methods as are here advised, or by immobilization in a Thomas's splint. We hold that it is important that the practitioner should be warned that, in such positions as these, splint treatment of a fracture is likely to be unsatisfactory, and that operative treatment should at least be considered without undue delay. We are glad to note that in dealing with

fractures of the lower end of the humerus the authors point out that the so-called 'separated epiphysis' is usually a fracture; but surely the same lesion is referred to on page 58 as a separation of the epiphysis. Is it correct to state that in fracture of the neck of the scapula there is lengthening of the arm? We have found this statement in other books as well as the one under review, but to us it has appeared impossible. Again, we find that fracture of the surgical neck of the humerus is a common accident; yet we have come to believe that the common fracture occurs considerably above the level of the surgical neck, and our opinion is confirmed by the photograph of the X ray which is intended to exemplify a fracture of the surgical neck. We should have liked to see greater stress laid upon the importance of rest and general treatment in fracture of the base of the skull, and consider the space given to fractures of the lower jaw scarcely adequate.

The diagrams are good, and the reproductions of X-ray photographs unusually clear, while the general finish of the volume is in keeping with the good level of the Oxford Medical Publications.

Surgical Emergencies. By RUSSELL HOWARD, C.B.E., M.S., F.R.C.S., Surgeon, London Hospital; Senior Surgeon, Poplar Hospital. Crown 8vo. Pp. 216 + viii, illustrated. 1924. London: Edward Arnold. 7s. 6d. net.

MR. RUSSELL HOWARD has undertaken a very difficult and exacting task in setting forth in the limited space of 200 pages "the methods of arriving at a diagnosis and the details of the operation to be performed in all the surgical emergencies with which a surgeon is likely to be confronted". He has covered a very wide field, and as a record of many years of experience in emergency surgery the book is of considerable value. It would appear, however, to be well-nigh impossible to include the many small but all-important technical details necessary for the guidance and safety of his junior colleagues, although he has attempted to do this in so far as the space at his disposal would permit.

The book commences with concise practical directions for dealing with hemorrhage, and passes on to the consideration of shock. The treatment of shock leaves a good deal to be desired, and the views expressed on its pathology do not accord with the doctrines of modern physiology. Wounds of the limbs are dealt with in detail, and the next five chapters are devoted to acute abdominal lesions, intestinal obstruction, and the after-treatment of abdominal operations. This is the best section of the book, and great stress is laid upon the importance of rest and sleep and all measures to obtain these, as opposed to stimulant treatment, in the management of post-operative abdominal cases.

The final chapters deal with emergency conditions met with in the surgery of the urethra, of the head, of the neck, and of the thorax and spine, the last chapter giving a brief account of the most important lesions of the ear and eye likely to call for immediate operation.

There are several points which call for criticism. Some of the operations described—for example, the more elaborate methods of treating fractures, and the radical mastoid operation—can scarcely be considered as emergencies. Some of the measures suggested—for instance, excision of a gastric ulcer as an alternative to suture after acute perforation—though safe in the hands of the author, might be dangerous if attempted by his junior colleagues. The illustrations are poor on the whole, and some of them are distinctly misleading, and do not illustrate what is described in the text. The picture of suprapubic puncture shows the cannula inserted midway between the pubes and the umbilicus; and the picture of sub-temporal decompression shows a left-sided bone defect which, if the operation were carried out as illustrated, would lead to a disastrous result. These minor mistakes, of which there are many in the book, coming from the pen of so well known a surgeon and teacher as Mr. Russell Howard, must not be allowed to pass without comment.

Radium, X Rays, and the Living Cells: with Physical Introduction. By HECTOR A. COLWELL, M.B. (Lond.), D.P.H. (Oxford), Assistant Radiologist, King's College Hospital; and SIDNEY RUSS, D.Sc. (Lond.), F.Inst.P., Joel Professor of Physics, Middlesex Hospital Medical School. Revised and enlarged edition. 1924. London: G. Bell & Sons Ltd. 21s. net.

THE authors of this text-book, which first appeared in 1915, rendered pioneer service to the subject of 'radio-biology' in producing it. It is always a difficult task to catch the first early outlines of a nascent science and to fix them in the framework of a text-book. That the attempt was successful is shown by the present revised and enlarged edition. The appearance of this work was significant in another aspect. It was one of the earliest products of close co-operation with a common aim between a medical man and a pure scientist. It seems likely that the future advance of medicine will increasingly depend upon such partnerships.

It is hardly necessary to enter into a detailed criticism of this well-known work. It opens with a physical section, doubtless contributed by Professor Russ, in which the fundamental facts about radium and X rays are stated authoritatively in a form intelligible to the non-physicist. In the later portions of the book the present state of our knowledge in regard to the effects of radiation upon living tissues, and especially upon neoplastic tissues, is fully set forth.

In the present edition the scope of several chapters has been extended to include recent experimental results, and a new chapter summarizes the action of radiation on living structures, and discusses the theories put forward to account for the observed results. A practical chapter upon the precautions to be taken by those habitually exposed to radiation might usefully have been added. In discussing secondary X rays the authors say, "Now that some of the fundamental properties of secondary X rays are known, it is highly probable that efforts may be directed towards their use". It seems strange that they do not mention the method of bismuth injection preparatory to X-radiation which was employed in the treatment of malignant disease, not without success, until the discovery of radium superseded it. The value of *Plate II*, an X-ray photograph by means of a crystal of zinc blende, would have been enhanced by a fuller description.

Apart from these criticisms on points of detail, we have nothing but praise for the book. It is indispensable to all surgeons interested in the therapeutic uses of radiation.

Collected Papers of the Mayo Clinic. Vol. XIII, 1921. Edited by Mrs. M. H. MELLISH. Pp. 1318, illustrated. London and Philadelphia: W. B. Saunders Co. Ltd. 60s. net.

THOUGH the personnel of the Mayo Clinic has considerably increased since their new offices were completed, it is nevertheless a matter for congratulation that not only the volume but also the quality of the literature put out from the clinic maintains the high level of the early publications. We are glad to note that Dr. William Mayo looms more largely in this volume than in the last. Since the war the character of his papers has undergone some change. We have here, it is true, two of purely clinical interest on the surgery of the spleen, but that on hepatic insufficiency breaks new ground, and as it is now realized that comprehension of the functions of vital organs is necessary if we are to understand their pathology when involved in disease, there can be no doubt that these papers will be often referred to. This paper, the second Murphy Oration, details many interesting facts in the career of that brilliant surgeon, and it is in this appreciation of the works of others, as is also seen in that of Henry Jacob Bigelow, read before the Boston Surgical Society, that the generosity of thought that pervades all his writings is most apparent. Dr. Mayo has recently broken out in another direction, for his address on "The Medical Profession and the Public" shows how one who has made a world-wide reputation as a surgeon may also develop valuable qualities as a publicist. The Mayo Clinic have placed the wealth of their experience without stint

at the service of the world ; surgeons in other countries with one per cent of the cases seen in the clinic have for their instruction details of the practice, both in preparation, operation, and after-treatment, which can save them from many difficulties and possibly fatalities ; thus Waltman Walters' paper "On the Preparation of Patients with Obstructive Jaundice" is typical of one of the most valuable results of so large an operative and collated experience.

The more purely scientific papers range over so wide a field that it is scarcely possible for anyone interested in any aspect of medicine to open the volume without finding something which it will profit him to read. The investigations by Georgine Luden on "Blood Cholesterol" open out a most important field in the relation of this substance to cancer research. There is no doubt that a very large amount of experimental work is summarized in Williamson and Mann's "Experimental Study of Post-operative Peritoneal Adhesions". It should help others experimenting in this field, for they have convinced themselves that all the substances hitherto employed have been useless in preventing adhesions ; and in recommending a gum-acacia-gelatin mixture as affording the best chance of preventing adhesions, they acknowledge certain difficulties in its use which they have not been able to overcome. Finally, we would like to draw attention to Rosenow's Mayo Foundation Lecture on "Focal Infection", which is remarkably stimulating in idea, and if pursued to its obvious ends in the clinical field may have very far-reaching consequences.

Excursions into Surgical Subjects. By JOHN B. DEEVER, M.D., Sc.D., LL.D., F.A.C.S., Emeritus Professor of Surgery, University of Pennsylvania ; and STANLEY P. REIMANN, M.D., Assistant Professor of Experimental Pathology, University of Pennsylvania. 8vo. Pp. 188, illustrated. 1923. London and Philadelphia : W. B. Saunders Co. Ltd. 21s. net.

DR. DEEVER is one of the most versatile and prolific of authors, and one of the most expert of living surgeons. When vast experience is combined with sane judgement, with an acute sense of the fitness and the worth of things, and with a gift of frank and lucid expression, a man's influence becomes world-wide. There are few surgeons who equal Dr. Deever in any of these attributes. Everything he writes is deserving of our serious attention.

This little book contains a series of papers written during the last few years, and several lectures delivered at Washington University. It is convenient to have them bound together for easy reference. Throughout all the chapters we find freshness of experience rather than originality of thought. There is no intellectual challenge ; no provocation comes from the statement of new truths ; but a delight is roused within us when we listen to a clear and candid examination of the old truths newly illustrated.

The lecture upon jaundice contains an interesting summary of the views held with regard to this symptom by the French writers and others. Chauffard's name, on page 60, appears twice as Chaufford. Few surgeons will agree with Dr. Deever when he asserts (p. 61) that Hanot's cirrhosis is possibly the final stage of Banti's disease. W. J. Mayo doubts the existence of Hanot's cirrhosis. It is more than probable that Hanot described both biliary cirrhosis and hæmolytic jaundice under the one heading. The term Banti's disease is better reserved for the final stage of splenic anemia. It has no connection, even of the remotest kind, with Hanot's cirrhosis, however we may interpret that disease.

In the lecture on diseases of the gall-bladder a classification of cases is introduced which appears to us to be strained and artificial. The preference for removal of the gall-bladder rather than its drainage will have the support of all surgeons to-day. The "Trials, Tribulations, Joys of a Surgeon" make a very interesting lecture.

The final chapter is headed "Living Pathology". Throughout the volume a reference here and there is made to 'living pathology'. The phrase 'the pathology'

of the living' was introduced into surgery many years ago by Moynihan. The thought that he desired to illustrate is not indicated by a change of his phrase into 'living pathology'. Pathology is not a state of the tissues, but is a science; and the term 'living pathology', if it means anything, surely signifies that this science is vital, active, and growing. That is not what Dr. Deaver intends, however true it may be. His meaning is Moynihan's meaning.

Dr. Stanley Reimann contributes a few sections to the book, all of them of interest and value.

La Pratique Chirurgicale Illustrée. By VICTOR PAUCHET. Fascicule IV. Octavo. Pp. 250, with 307 illustrations. 1923. Paris: Librairie Octave Doin. 25 francs net.

THIS is the fourth portion of an Illustrated Practical Surgery, the previous portions of which have been reviewed in this JOURNAL.

The present volume deals with the surgery of the breast, duodenal ulcers, biliary passages, appendix, some diseases of the rectum, and some operations upon the uterus and appendages. The book is characterized by most profuse illustrations depicting the various stages of different operations. These illustrations are very good, and no doubt will be useful to many.

Die Chirurgie des Anfängers. By DR. GEORG AXHAUSEN, Professor of Surgery in the University of Berlin. 1923. Berlin: Julius Springer. 4.50 dollars.

THE best form of preliminary instruction in medicine and surgery is one of the questions which is giving rise to much thought in medical schools to-day. It is frankly admitted that our present methods are not satisfactory, and in consequence it is of interest to look and see what is being done in other countries. Professor Axhausen has written a book of 440 pages, well bound and illustrated. It comprises three chapters—on general surgical principles, methods of examination of special parts, and the principles of operative surgery. The book is good of its kind, but it does not yet satisfy the wants of the student who wishes to learn medicine as a science and not as a craft.

Chirurgie de la Tête et du Cou. By CH. LENORMANT and P. BROCCQ. Sixth edition. Crown 8vo. Pp. 338 + viii, with 245 illustrations. 1923. Paris: Masson et Cie.

THIS book, one of a series of seven volumes entitled "Précis de Technique Opératoire", has reached its sixth edition, the first having appeared in 1904. It embraces a surprising medley of operations, ranging from removal of the Gasserian ganglion to the extraction of a wisdom tooth. The steps of each operation are briefly related, and are illustrated, in many instances remarkably well, by a large number of semi-diagrammatic pictures.

For a student wishing to refresh his memory before an examination, the little book should prove valuable, but one can scarcely agree with the opinion expressed in the preface that every practitioner ought to know how to carry out these operations, "since the practice of surgery is no longer confined, as formerly, to the hands of a chosen few". There would not be many who would care to entrust to the average doctor such procedures as hypophysectomy, laryngectomy, or excision of the cervical sympathetic, nor would many general practitioners be prepared to carry out the removal of a cerebellar tumour through an osteoplastic craniotomy. On the other hand, the accounts of such operations as tracheotomy, mastoid anotomy, and the like, clearly described and well illustrated as they are, give the book a reasonable claim to a place in the general practitioner's library.

Les Ulcères de l'Estomac et du Duodénum. By ED. ENRIQUEZ and GASTON DURAND.
Crown 8vo. Pp. 184, illustrated. 1923. Paris: Masson et Cie. 10 francs net.

THIS small volume concerns itself with diagnosis. After a brief historical account, the book is divided into two parts: (1) Diagnosis of the lesion; (2) Diagnosis of the seat of the ulcer. It is a book of value in that it gives the views of our French colleagues on diagnosis and methods of examination.

Traumatismes du Poignet et Rayons X. By ETIENNE DESTOT, Lyon. Royal 8vo.
Pp. 174, with 184 figures. 1923. Paris: Masson et Cie. 16 francs net.

THIS is the posthumous work of Destot, which was finished by him, but not published, in 1918, a little before his death. In this book attention is called to the injuries of the wrist which previously were little known or studied, and the matter is dealt with altogether in an admirable style. The only criticism is with the printing of the skiagrams. These are generally useless, owing to the inferior quality of the paper and the method of reproduction, which completely spoil a good monograph.

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EPONYMS.

BY SIR D'ARCY POWER, K.B.E., LONDON.

XIV. WHEELHOUSE'S OPERATION.

GONORRHOEA is a very old disease; from time to time our arboreal progenitors must have ruptured their urethras by carelessly falling astride of a branch; and the numerous operations for stone in the bladder in later days was followed by stricture of the urethra in a certain proportion of cases. Retention of urine is a troublesome condition, and its treatment is often urgent. The historical medical museums at Naples and in London show that catheters were an early invention, but surgical literature proves that the morbid anatomy of stricture was ill-understood. Galen seems to have thought that it was due to ulceration of the bladder; later opinion placed the seat of ulceration at the neck of the bladder or in the prostatic portion of the urethra, and throughout the middle ages retention of urine was stated to be caused by 'polypi' or 'earuneles' in the urethral canal; only lately has the real pathology of stricture been correctly explained. The treatment of the slighter forms of stricture has never presented much difficulty, but impervious strictures were a real bugbear to the older surgeons. Some confessed frankly that nothing could be done, and left the patient to Nature, hoping that the urine would become extravasated; others, bolder, used caustics of lime or arsenic to destroy the 'earuneles'; a few, like Ambroise Paré and Amussat, devised cutting probes with which they performed internal urethrotomy.

Astruc, who wrote a most useful and instructive history of venereal disease, says in 1736, after discussing the causes and treatment of urethral stricture. "But if no sort of catheter can be introduced there is only one method left of preserving the patient: to wit, to pass a trocar through the wound in the perineum directly into the bladder according to the known direction of the urethra, and by this means draw off the urine. We do not deny that the instrument in this operation deviates from the natural duct of the urethra, and wounds its coats in passing into the bladder. But what then? In the present danger of death it is better to try a doubtful remedy than none: neither are wounds of the urethra of such a nature that they will not admit of a cure. But as in former cases so in this, a pipe must

be kept in the bladder till there is a free passage through the urethra and the tone of the bladder is perfectly restored; and lastly, the pipe being drawn out, the wounds of the urethra are to be cleansed, carnified, and cicatrized according to the rules of our art." Astruc's treatment was followed for many years, though it was modified by Edward Coek, surgeon to Guy's Hospital, who published in 1852, in the *Transactions* of the Medical and Chirurgical Society, his paper on forty cases of retention of urine in which the bladder was punctured through the rectum.

In 1844 Professor Syme, of Edinburgh, published an account of his method of treating obstinate strictures of the urethra by external urethrotomy. He passed a small grooved director not exceeding in size the largest knitting-needle which could be passed through the stricture; cut down upon it through the perineum, and thus divided the stricture. The disadvantage of Syme's operation lay in the fact that it was unsuitable for impermeable strictures, as a filiform staff had first to be passed; but it was largely used for many years.

Mr. Claudius Galen Wheelhouse published part of a clinical lecture in the *British Medical Journal* for Feb. 5, 1870. The lecture was given in the Leeds School of Medicine upon two patients with impermeable stricture of the urethra, and in it he pointed out the advantage of using a grooved lithotomy staff rather than a sound or catheter in performing external urethrotomy. He also laid stress upon the advisability of opening the healthy urethra in front of the stricture, instead of cutting down upon the stricture itself as was done by Syme. He then went on to say: "I next seize with artery forceps each lip of the opening I have made into the urethra, and with these draw upon the canal, carefully assuring myself that the mucous membrane is included. The position of the staff is next completely altered. Taking it in my own hand, I reverse it, turn the point out through the opening I have made, and use it to draw forward, fix, and steady the urethra. If the parts are now carefully sponged, I have the interior of the canal so fully exposed to view that I can steadily follow its upper wall; this I do with a fine probe-director until I have cut my way completely through the stricture, and have come out into the dilated part of the urethra, which usually lies behind it, or, as sometimes happens, into a second or more strictures; this effected, I am generally able to pass the small director which I have been using immediately onwards into the bladder. Now, at this point I have seen the most skilful operators completely baffled; and although they have succeeded in effecting the division of the stricture most perfectly, I have known them fail entirely in their attempts to carry the catheter onwards into the bladder. Without a guide it is often a most perplexing and difficult matter to find the opening into the posterior portion of the urethra, or, when this is found, to insinuate the catheter into it by the side of the director; and it is precisely at this point that my little grooved director becomes of all important service. Having reached the bladder with that, I turn the groove downwards; with a straight probe-pointed bistoury run along it, I make sure of the division of any further obstructing bands, and finally I completely open up the prostatic urethra by sliding along the groove of the director the little instrument which I now show you, the 'probe-dilator', an instrument introduced by the late Mr. Teale



CLAUDIUS GALEN WHEELHOUSE

(1801–1867) for use in lithotomy, and thus obtain a broad metallic floor upon which I can, without any danger of failure, introduce a catheter of even the largest size."

It will be seen that this lecture contains the essence of an operation which Mr. Wheelhouse afterwards standardized, and which has since come into very general use.

It was some years before the advantages of the operation were recognized. Writing to the *British Medical Journal* on June 24, 1876, Mr. Wheelhouse says: "Notwithstanding the length of time that has elapsed since I brought



FIG. 151.

before the profession my method of finding my way in cases of impermeable stricture from the perineum, *through* the stricture and into the bladder, the subject seems to have received so little notice that I deem it advisable once more, after several years of successful employment of the

operation, to revert to the subject. The instruments required are as follows: lithotomy bandages; a special staff fully grooved through the greater part, but not through the whole of its extent, the last half-inch of the groove being 'stopped', and terminating in a rounded button-like end (Fig. 151); an ordinary scalpel; two pairs of straight-bladed forceps, nibbed at the points: ordinary artery forceps and ligatures; sponge; a well-grooved and finely probe-pointed director; Teale's probe-gorget (Fig. 152);* a straight probe-pointed bistoury; a short silver catheter (No. 10 or 11 gauge) with elastic tube attached." The details of the operation are then given, and they do not differ materially from those previously described, though it may be noticed that as a result of further experience Mr. Wheelhouse had replaced the lithotomy staff which he used originally by a specially designed straight staff, and the curved by a straight catheter.

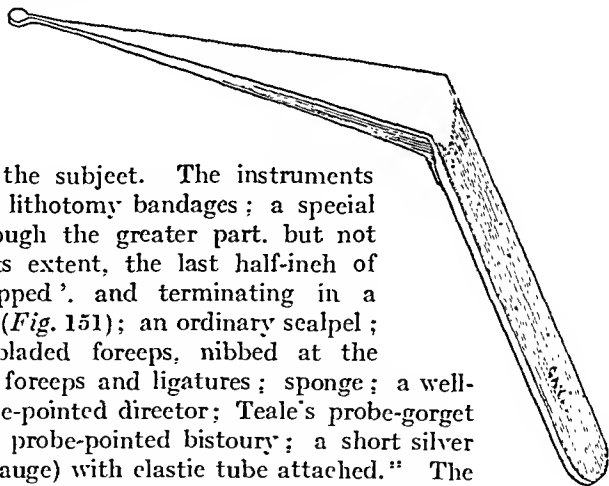


FIG. 152.

Claudius Galen Wheelhouse was born at Snaith, in Yorkshire, on Dec. 29, 1826, and died at Filey on April 9, 1909. He was the second son of James Wheelhouse, a surgeon, and was educated at the Bluecoat School in London. He was apprenticed at the age of sixteen to R. C. Ward, of Ollerton, Newark, and entered the Leeds School of Medicine in October, 1846. He qualified M.R.C.S.Eng. in 1849, and L.S.A. in the following year. He then went to the Mediterranean on a yachting cruise as surgeon to Lord Lincoln, afterwards fifth Duke of Newcastle and Secretary of State for War. He took with

* Figures 151, 152 are reproduced from the *British Medical Journal*, June 14, 1876.

him one of the first photographic cameras which left England, and obtained many good photographs in spite of the cumbrous processes then in use.

Returning to England in 1851 he entered into partnership with Joseph Prince Garlick, of Park Row, Leeds, the senior surgeon to the dispensary and lecturer on surgery at the Leeds School of Medicine. In the same year he was elected surgeon to the Public Dispensary and demonstrator of anatomy in the Medical School, where he was successively lecturer on anatomy, physiology, and surgery. He was twice President of the School, and when the new University of Leeds was inaugurated in October, 1904, Wheelhouse was made an honorary D.Sc. He served on the Council of the Royal College of Surgeons of England from 1876 to 1881, and presided at the Leeds meeting of the British Medical Association in 1889. He was also an elected representative of the medical profession upon the General Medical Council from 1886 until 1896.

The portrait is from a photograph kindly lent by S. F. Cowell, Esq., M.A., Secretary of the Royal College of Surgeons of England.

THE SECTIONAL PLASTER-OF-PARIS CASING WITH REFERENCE TO THE TREATMENT OF FRACTURES OF THE LEG AND ANKLE: CASE REPORT.

By W. A. COCHRANE, EDINBURGH.

THE criterion of function as the standard for judging the end-results of fractures is of great significance with regard to those of the leg, ankle, and foot. The deliberations of such bodies as the Fracture Committee of the British Medical Association in 1914 emphasize its importance especially in respect of the restoration of anatomic alinement. The Committee concludes that no method of treatment should be adopted which does not secure restoration and maintenance of anatomic alinement. Consideration of fractures in the region of the ankle demonstrates that in them, as in all articular and para-articular fractures, the effect of the injury upon the neighbouring joint is of greater importance functionally than the effect upon the bone itself. Restoration of anatomic alinement is necessary if the axes of the joint are to be correct as to their line of action and to the proper functioning of the tendons acting on and over it. P. D. Wilson, of Boston, has formulated the following rules as fundamental in the treatment of fractures of the ankle and of the bones of the leg:—

1. Complete anatomic reposition should be the goal in all cases, but slight displacement is not incompatible with good function, provided that the axes of the main fragments of the tibia remain parallel, and the tibio-astragaloid joint lies in the normal horizontal plane. In general, angular deformity is more to be feared than any other type of displacement.

2. When rigid dressings are necessary, care should be taken to fix the foot and ankle in the position of optimum function, that is, with the ankle at right-angle flexion, the foot inverted, and the arches supported.

3. The fundamental supporting structures of the foot being muscular,



FIG. 153.—Antero-posterior skiagram of fracture-dislocation of the ankle. The foot and the malleoli have been displaced medially in relation to the bones of the leg.

it is of the utmost importance to preserve their tone and strength by beginning massage and active movement at as early a date as possible.

4. When weight-bearing is first permitted, the foot being weak, a certain amount of support should be provided by the use of a heel whose inner border is elevated. This slightly inverts the foot and holds it in a position of strength. Unprotected weight-bearing should not be permitted until the muscular function is good.

A large majority of fractures of the bones of the leg, and nearly all frac-



FIG. 154.—Lateral skiagram of the same: it shows the posterior dislocation of the ankle, and the fact that the malleoli are also displaced backwards.

tures and fracture-dislocations of the ankle, may be successfully treated by immediate reduction of the displacement under an anæsthetic, followed by immobilization in a plaster-of-Paris casing. With regard to fractures of the bones of the leg, simple fractures with displacement which are more or less transverse and are uncomminuted, come into this category. In those which are compound, comminuted, and are oblique or spiral in direction, traction methods or operation are best. It is the first group that is considered in this communication. The casing may be bivalved at once, and massage begun on the foot and leg as they lie in the posterior section of the casing. In a large series of cases, observed or treated by the writer, no interference with the circulation has taken place; although, in point

of fact, the bivalving of the casing would help to prevent it. Nor has it been his experience that these fractures are usually associated with swelling, such as the books describe, sufficient to contra-indicate the use of plaster-of-Paris. It is fears such as these, which have no foundation in fact when the plaster is carefully applied, that, in the writer's opinion, have militated against the more general employment of the very best retention means at our disposal in certain fractures.

The main difficulty in fractures of the leg and ankle lies, however, not in the actual reduction of the displacement, provided an anæsthetic is employed, but in the maintenance of the corrected position while immobilization, whether by splint or by plaster, is being secured. The ordinary means of splintage, as in the use of the box-splint or in the special splints which have been devised from time to time, are too haphazard in this respect. While one of these means is being employed, the fracture redisplaces, or does so subsequent to the patient's return to bed. All the work of reduction and the risk of the anæsthetic go for nothing, and the patient is in the unfortunate position of having to subject himself to another attempt at reduction, with the certainty of the same thing happening again. "But", someone will say, "such a case should be treated by other means, by operation, say, or by traction in a Thomas's splint". Such a reply, in the writer's opinion, simply begs the whole question of the possibility of treating the large group of cases referred to by the reduction and fixation method. Further, there is no question, in the case reported here, that treatment by operation or by traction could not have fulfilled the demands of the case.

It is with the main object of demonstrating that a precise, simple, and eminently practical method is available for such cases as are difficult to hold while fixation is being applied, that this communication is made. It involves the employment of a plaster-of-Paris casing applied in sections.



FIG. 153.—Over-correction of the mesial displacement of foot and malleoli.

CASE REPORT.

The following case, a fracture-dislocation of the ankle, is therefore reported at this time, as being of special clinical interest and importance with reference to the success which attended the use of a special method—a plaster-of-Paris casing applied in sections—in securing and maintaining reduction in a difficult class of case which had resisted the methods of reduction and immobilization commonly employed.

The patient, a middle-aged adult, was admitted to hospital on Jan. 16, 1924, with a simple fracture-dislocation of the right ankle, sustained in a street accident. She was knocked down by a motor cycle, the foot being caught and twisted by the machine. Clinically, there was present gross backward and inward displacement of the foot in relation to the leg. There was very little swelling. The antero-posterior skiagram (Fig. 153) revealed a fracture

through the base of both malleoli, with mesial displacement of the foot and malleoli. The lateral skiagram (*Fig. 154*) showed a complete posterior dislocation of the ankle, with posterior displacement of the malleoli.

Under the anæsthetic, reduction in both planes was obtained without much difficulty. The fact that the bony points about the foot and ankle were restored to the normal, and that the foot could be dorsiflexed beyond the right angle, was proof of this. As soon as support was altered or removed in the slightest degree, however, it was evident that the posterior dislocation

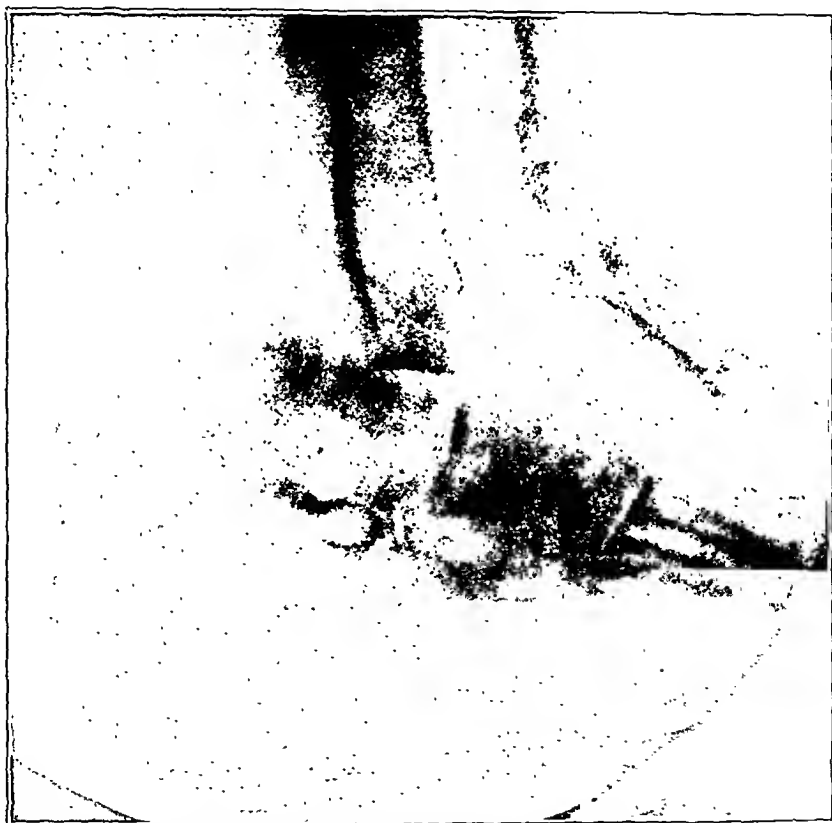


FIG. 156.—Profile view taken through plaster casing shows that the posterior dislocation has not been reduced.

recurred with the greatest ease. The extensive tearing of the ligaments was responsible in part, but a factor of greater importance, doubtless, lay in the loss of support to the astragalus normally provided by the malleoli when intact. Reduction being effected once more, the limb was encased in plaster-of-Paris from the toes to the middle of the thigh, with the knee flexed 30 degrees. Every effort was made to prevent recurrence of the dislocation while this was being done. The subsequent skiagrams (*Figs. 155 and 156*) showed, however, that while the displacement mesially had been over-corrected, the posterior dislocation was still unreduced. What had happened was that, in

making way for the turns of the plaster bandage, a momentary slackening of the hold, or an alteration in the position of the surgeon's hands, had allowed the corrected position to be lost, and that in spite of one's appreciation of its imminence. The writer felt that he was not justified in subjecting the patient to a second attempt at reduction unless a method or device more accurate and precise was available. It was desirable that a method should be adopted which would guarantee that, having secured reduction, it would not be lost again by the surgeon's hands requiring to alter their position, even momentarily, while immobilization was being secured in a plaster-of-Paris casing. As has been pointed out above, that is the crux of the whole question in such cases.

The Three-piece Sectional Plaster-of-Paris Casing.

A little thought suggested the idea that such a method was available and practicable, if the principles underlying the employment of a plaster-of-Paris casing, put on in two or more sections, as is done in orthopædic surgery, could be adapted to the fracture-dislocation in question. It was evident, then, that if separate plaster casings were applied, and allowed to set, above and below the area involved—in this case the ankle—so leaving it free for manipulation, the surgeon could correct the dislocation vigorously, and his assistant unite the two plasters by a third plaster bandage. The surgeon's hands would be out of the way of the turns of the third bandage as they were being applied, and therefore there would be no question of his hands requiring to alter their force or position meanwhile.

The first casing was removed. All swelling had subsided. An anæsthetic was administered, and over stockinette and woollen bandages the first section of the plaster was applied from a point two finger-breadths above the level

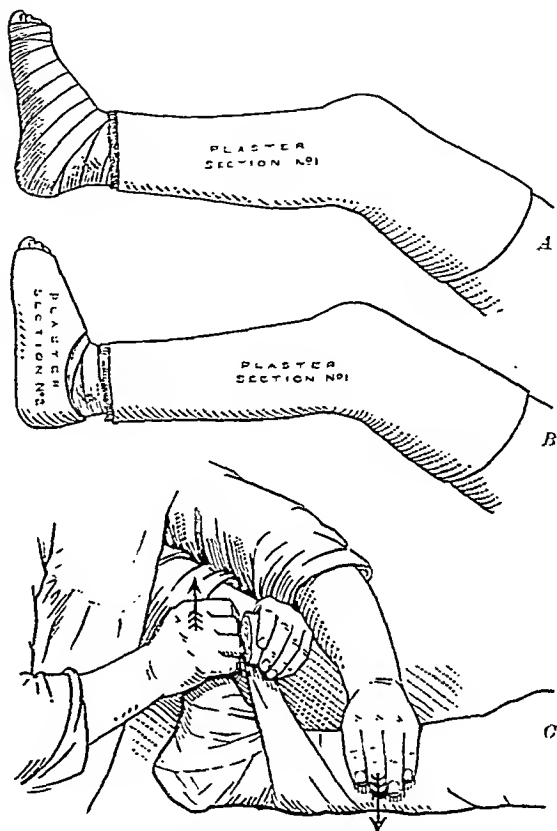


FIG. 157.—Illustrating the three-piece sectional plaster-of-Paris casing. *A*, Drawing from a photograph, showing the first section of the plaster casing applied. Note the projecting edge of the cuff of felt referred to in the text. *B*, Nos. 1 and 2 sections of the sectional plaster, leaving the region of the ankle free. *C*, Drawing from a photograph to show how reduction of the posterior fracture-dislocation is effected. Note that the foot is fully dorsiflexed and slightly inverted.

of the ankle-joint to the mid-thigh. Care was taken to encircle the leg just above the ankle with a cuff of sterilized felt, 4 in. broad, to take the backward pressure to be borne by this part of the anterior aspect of the leg in reducing the dislocation. The knee was flexed 30 degrees to relax the calf muscles and so allow of free dorsiflexion of the foot in the final position (*Fig. 157, A*). The heel being protected with a square of white felt, a second section of the plaster encased the foot, and was moulded by the hands to support the arches. This left the ankle free of plaster and ready for manipulation (*Fig. 157, B*). The two sections were allowed to set, and then the edges were trimmed and everted to avoid risk of pressure by them upon

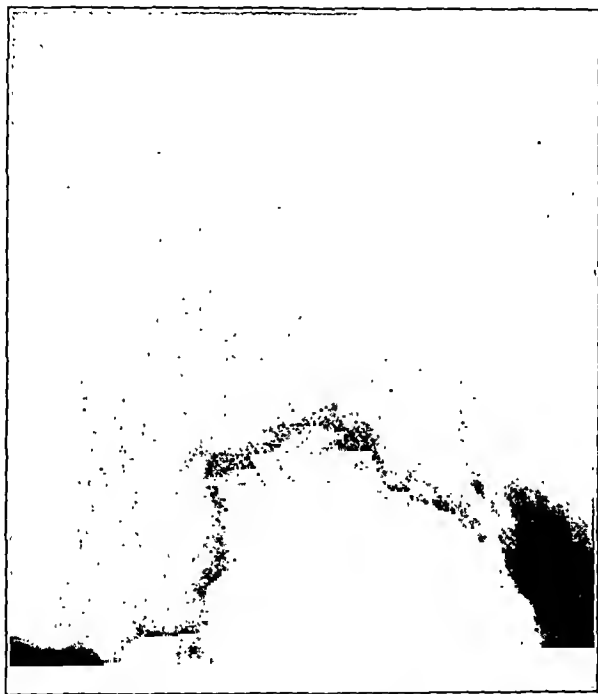


FIG. 158.—Antero-posterior view after treatment by sectional casing.

the soft parts in the final position of correction. The manipulation to secure reduction of the posterior dislocation was then made by pressing backwards with the flat of the left hand on the anterior aspect of the lower end of the first-applied cast, while the right hand seized the plaster encasing the foot and pulled it forwards vigorously (*Fig. 157, C*). Reduction was felt to take place quite easily, as before. The foot being fully dorsiflexed and in slight inversion, it was possible for the surgeon to maintain the reduction strongly and with absolute certainty, while an assistant united the two plasters by a few turns of a plaster bandage. In this way the third and last section was applied and the casing completed (*Fig. 157, C*). The whole point in the rationale of the scheme lay, then, in the fact that, once reduction was

effected, it was never again in jeopardy or exposed to the risk of redisplacement.

Subsequent skiagrams (*Figs. 158 and 159*) showed that reduction in both planes had been secured. The limb was immobilized in the original plaster for six weeks to allow the malleoli to unite and the torn ligaments to heal. On lifting the limb from the splint, the patient had immediate power of moving the foot and ankle to quite an appreciable degree, and with massage the range of active motion is steadily increasing. The final result promises well as to ultimate function.



FIG. 159.—Lateral view of same.

The Three-piece Sectional Plaster of Fiske.—The device detailed above really represents an adaptation of the method of Fiske, of Chicago, in his treatment of congenital club-foot by a three-piece plaster-of-Paris casing. It was from having used Fiske's technique in such cases that the idea occurred to the writer that it might be adapted as a practical solution of the problem presented. In the case of congenital club-foot, Fiske pointed out that the various deformities were best corrected slowly in a plaster casing applied in sections, over stockinette made to adhere to the leg and foot by Sinclair's glue. A plaster-of-Paris casing is applied to the foot itself below the malleoli, suitably protecting the bony points with tiny squares of white felt. As the plaster sets, the surgeon seats himself opposite the child, who

is seated on his mother's knee, and moulds it carefully to secure correction of the flexion of the toes, the adduction of the foot, and the mesial tilting of the os calcis. These three deformities are all located in the foot itself. There remain three deformities of the foot in relation to the leg, namely, equinus, inversion, and internal rotation. The second plaster is therefore applied to the leg from a point just below the knee to a point just proximal to the ankle-joint. When it has hardened, foot and leg are grasped, and the former is brought gently into a position of dorsiflexion, eversion, and external rotation. The assistant then joins the two plasters by a third, and so completes the casing.

Fig. 160 represents the end-result of a typical case after nine months' treatment and four successive plasters. The method does not require an anæsthetic, is not forcible, and functionally gives the best results possible.

The Sectional Plaster in Fractures of the Bones of the Leg.—The writer owes to his association with Dr. P. D. Wilson, of Boston, instruction in a method used extensively by the latter in the Fracture Service of the Massachusetts General Hospital, and which the writer has employed since (*Fig. 161*). The patient is anæsthetized and placed on his back on a firm table with the buttocks resting on the edge. The uninjured leg rests on a chair, while an assistant holds the fractured leg. The foot and ankle of the fractured leg are now encased in stockinette and woollen roller bandages. The foot and ankle are padded with an ankle of thick felt, and a piece of strong bandage, 10 feet long, is tied over the ankle as a



FIG. 160.—Final result in a case of congenital club-foot treated by the three-piece sectional plaster technique of Fiske. Full voluntary over-correction is possible. A supplemental operation was necessary in this case.

clove-hitch, leaving the ends long. The loose ends are knotted around the hips of the assistant, so that, by leaning backwards, he may exert traction on the leg, while his hands are left free to support the foot. The knee is flexed to a right angle, and a wide bandage is made to encircle the thigh just above the knee. The ends, left long, are held by an assistant, who stands at the head of the table and exerts counter-traction. By this means, and by manipulation of the fracture itself, the fracture is reduced and the position maintained by the traction. The plaster casing is then applied in two sections. The first section extends from the ankle to the groin, and, when it has hardened, the ankle-sling is removed. The foot and ankle are then encased in a separate plaster and united to the first section. The foot is dorsiflexed and slightly inverted. Care must be taken not to include the traction-bands in the cast. The bandage round the thigh may be withdrawn in time, by not including it completely in the first instance, after which the gap is rapidly covered in by the plaster, and the assistant supports the knee and thigh manually.

It is a safe rule in all these cases to see the patient on the same day as that on which the cast is applied, and on the next day also. If any doubt exists as to the integrity of the circulation, the cast and its lining may be bivalved. In a large series of cases, the writer has seen no difficulty from this source, nor any untoward local pressure effects by the plaster.

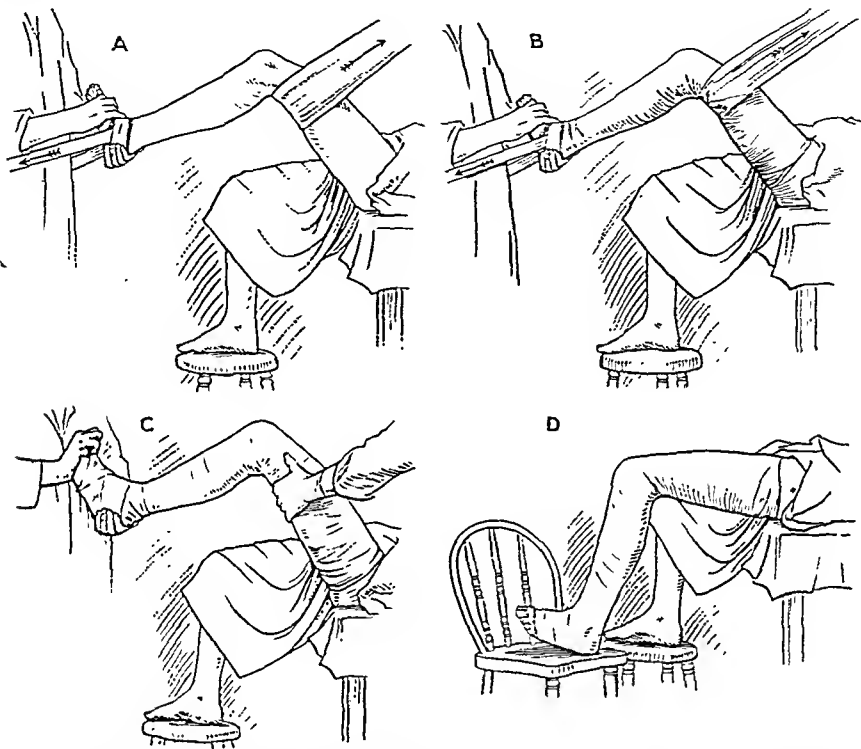


FIG. 161.—Reduction of a fracture of the leg by the traction method. A, Traction is obtained by passing a piece of bandage about the ankle in the form of a clove-hitch, a soft pad of felt being interposed between it and the skin. The ends of the bandage are knotted about the hips of an assistant, who supports the foot manually and exerts traction by inclining the body backwards. Counter-traction is obtained by a supporting band passing around the lower part of the thigh which holds the knee flexed. B, In this position a plaster casing is applied in sections. The first section extends from the ankle to the groin, space being allowed for the removal of the counter-traction band. C, When this has hardened, the traction bands are removed and the foot is supported manually while the remaining portion of the plaster is applied. D, Plaster completed.

The Process of 'Wedging' the Plaster Casing in the Correction of Residual Deformity.—Subsequent skiagrams are taken through the plaster. As a rule, the position is satisfactory, but, should some angular deformity exist, it is possible to correct it by a process of 'wedging' (*Fig. 162*). Opposite the site of fracture, the case is cut in a circular manner for three-quarters or a little more of its circumference, leaving it intact opposite the obtuse angle of the angulation deformity. Using this intact portion as a hinge, it is possible to bend the cast in the appropriate manner necessary for the correction of the angulation. In doing so, the edges of the cleft in

the plaster are separated. To prevent their springing together again, little blocks of wood are put into the cleft, to maintain correction when the surgeon lets go his hold. The cast is then strengthened by a few turns of a plaster bandage. The principle of wedging is applicable to other fractures, notably in the forearm, as, indeed, is the principle of the sectional plaster.

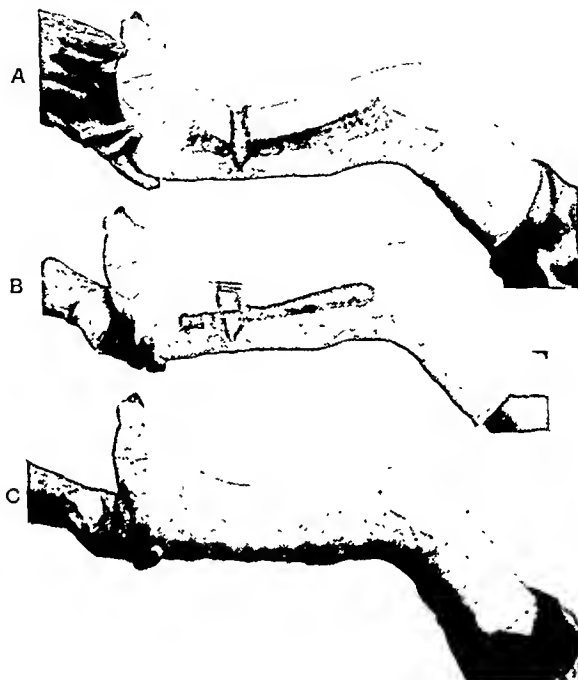


FIG. 162.—'Wedging' the plaster casing in correction of the residual deformity. A, The black line represents a fracture with posterior angulation. The cast has been cut in a circular fashion at the level of the fracture, leaving the casing intact posteriorly. B, The angulation has been corrected, and, to prevent recurrence of the angulation, little blocks of wood have been inserted to keep the edges of the cleft apart. C, A plaster bandage is then employed to cover in the whole, and the casing made complete again.

CONCLUSIONS.

1. In fractures of the bones of the leg and in the region of the ankle, restoration to the anatomic normal is especially essential for function.
2. A large majority of these cases may be successfully treated by immediate reduction and fixation.

3. A general anæsthetic should always be employed.

4. A plaster-of-Paris casing furnishes the best means at our disposal for securing immobilization. In a large series of cases the writer has seen no untoward circulatory or pressure effects from its careful and proper employment. In his opinion, the splints in common use for these cases should be discarded.

5. Fractures of the bones of the leg and fracture-dislocations of the

ankle present their main difficulty, not in the actual reduction of the fracture, but in the maintenance of the corrected position while immobilization is being secured.

6. The ordinary means of securing immobilization are too haphazard in this respect.

7. A precise, accurate, simple, and practicable method, in the form of a plaster-of-Paris casing applied in two or more sections, is available. The device is based upon the three-piece sectional plaster method employed by Fiske in the treatment of congenital club-foot.

8. The process of 'wedging' makes very fine adjustments possible, especially with reference to angular deformity.

9. In the writer's opinion and experience, the sectional plaster-of-Paris method should be the method of choice in all cases with displacement, where immediate reduction and fixation are indicated.

10. In the especially difficult case, such as here reported, it becomes the method of necessity, for neither traction methods nor operation would have been likely to succeed.

The writer is indebted to Professor Sir Harold J. Stiles for permission to report this case.

SQUAMOUS-CELLED CARCINOMA OF THE RENAL CALIX.

By GEOFFREY KEYNES, LONDON.

MALIGNANT growths of any part of the renal pelvis are stated to be rare, and up to the year 1922 only the comparatively small number of 56 cases had been recorded in the medical literature of the world.¹ The total has now been increased to 60 or more, one of the additions having been made in a recent number of this journal by Mr. Geoffrey Hadfield,² who recorded most of the known facts relative to the condition. A considerable proportion of these tumours are found to be associated with calculi, but it is not as a rule possible to determine whether the carcinoma preceded or followed the formation of the calculus. It has usually been assumed that the carcinoma was consequent on the irritation caused by the calculus, but this assumption is not justified in view of the fact that many more malignant growths occur in the absence of calculi than with them. Very few of the recorded renal carcinomata were, on the other hand, associated with a hydronephrosis. Whether or not the carcinomata were preceded by leucoplakia of the epithelium of the pelvis or by chronic ulceration is in most instances difficult or impossible to determine. Only a very close examination of the case histories could throw any light on this point.

The purpose of the present article is to record two remarkable instances of renal carcinoma. The first, which was associated with calculus and pyonephrosis, presents several points of interest, both clinical and pathological. The second was associated with a hydronephrosis of the congenital type, and is chiefly of pathological interest. The records of a third case have been added to the series, since it illustrates in a striking manner the possible origin of a carcinoma in the pelvis of a hydronephrotic kidney, both leucoplakia and chronic ulceration being present.

CASE 1.—A bookbinder, age 35, had enjoyed good health until the end of September, 1920. He then began to suffer from pain in the right side of his abdomen, associated with the presence of blood in his urine. The pain was not severe, and his general health had remained good. There was no increased frequency of micturition. An abdominal operation had been performed in infancy, but for what disease could not be ascertained. Hæmaturia had been noticed on *one* occasion six years before.

The patient was admitted to St. Bartholomew's Hospital on Oct. 18, 1920. He appeared to be thin and somewhat anæmic, but said that this was his normal appearance, and would not admit to having been ill for more than about three weeks. On examination he was found to have a large, fluctuating tumour in the right loin. Cystoscopy showed a normal bladder, but a purulent efflux was seen to come from the right ureter. X-ray plates showed the presence of a large branched calculus in the pelvis of the right kidney, and a diagnosis of 'pyonephrosis with calculus' was made. On

Oct. 26 a right nephrectomy was performed by Mr. T. P. Dunhill, a greatly enlarged kidney being removed through the usual incision in the flank. Some adhesions, thought to be inflammatory, were encountered at the lower pole, but no great significance was attached to these. The kidney, when split open, presented the appearance shown in *Fig. 163*. Each lobulation corresponded to a dilated calix containing pus, and five of the calices contained calculi. Another large calculus occupied the pelvis of the kidney, and possessed a short 'beak' projecting into the ureter. The calices at the lower pole contained some blood-clot as well as pus. The kidney tissue appeared to be



FIG. 163.—*Case 1.* Kidney split open along its free border, showing calculi in pelvis and calices. The white area in the wall of the calix near the lower pole on the right side shows carcinoma in section. A, Carcinomatous area.

almost non-existent, the organ having been converted into a multiloculated cyst with fibrous walls. The original diagnosis seemed to be confirmed, and the prognosis was regarded as being favourable.

The patient's convalescence was normal, and the discharge from the wound had ceased by Nov. 8, thirteen days after the operation. He was sent to a convalescent home soon afterwards.

On Dec. 7 the patient returned to his own home, and on the following day he noticed a recurrence of the tumour in the right side of his abdomen. He was re-admitted to hospital on Dec. 16, and was then found to have a large

fluctuating swelling in the same situation as before. There was a small mass of 'granulations' at one end of the operation wound, which was again discharging some purulent fluid. On Dec. 17 the operation wound was partially re-opened, and about two pints of foul pus were evacuated. Following this, the supposed granulations on the surface increased rapidly in amount, and began to undergo a superficial necrosis. At the same time the abdominal swelling became larger, in spite of the drainage which had been established. A microscopic section from the granulations was made on Dec. 24, and cells resembling those of round- and spindle-celled sarcoma were seen. It was evident at this stage that the original diagnosis would have to be revised, and a further examination of the kidney, which had been sent to the hospital museum, was undertaken.

It was now noticed that the wall of one of the calices in the lower



FIG. 164.—Case 1. Infiltration of the walls of the kidney with a squamous-celled carcinoma. The surface of the epithelium of the calix is shown at the top of the photograph ($\times 95$).

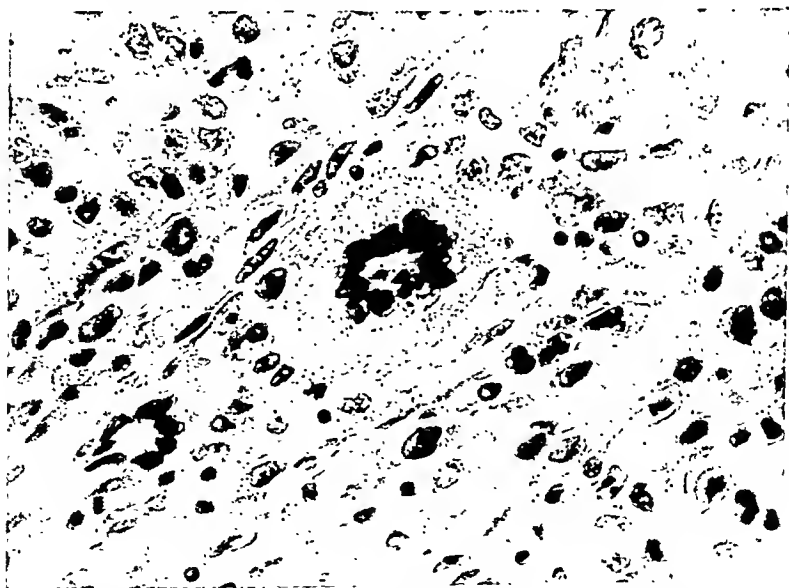


FIG. 165.—Case 1. Section of the growth immediately outside the kidney, showing metaplasia of the carcinoma cells, including giant-cell formation ($\times 540$).

pole was thicker and of a whiter appearance than in the others (*Fig. 163*). Sections were made from this region, and it was found that no sarcoma cells were present, but that the wall of the calix was infiltrated with a typical squamous-celled carcinoma (*Fig. 164*). Immediately outside the kidney capsule the type of cell showed a considerable degree of alteration, even multinucleated giant cells being a feature of the growth in this situation (*Fig. 165*).

Meanwhile the patient's condition became rapidly worse, and he died on Jan. 10, 1921, eleven weeks after the removal of his kidney. During the last fourteen days of his life the growth in his flank increased in size with extraordinary rapidity, and at his death a black, fungating mass nine inches in diameter projected from his flank for two inches beyond the surface of the skin. The intra-abdominal tumour was as large as a child's head.

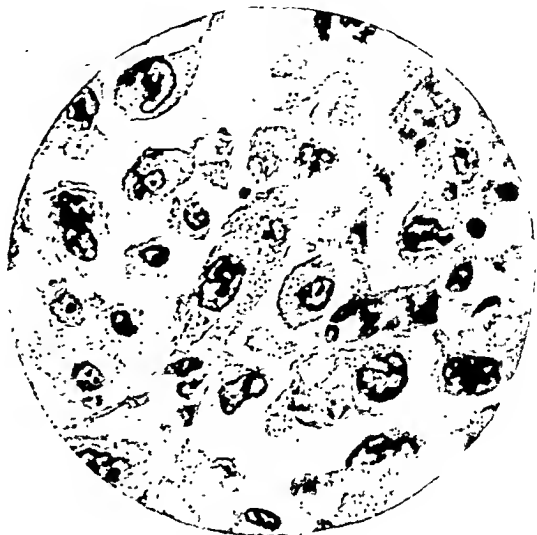


Fig. 166.—*Case 1.* Section of the recurrent growth in the flank ($\times 540$).

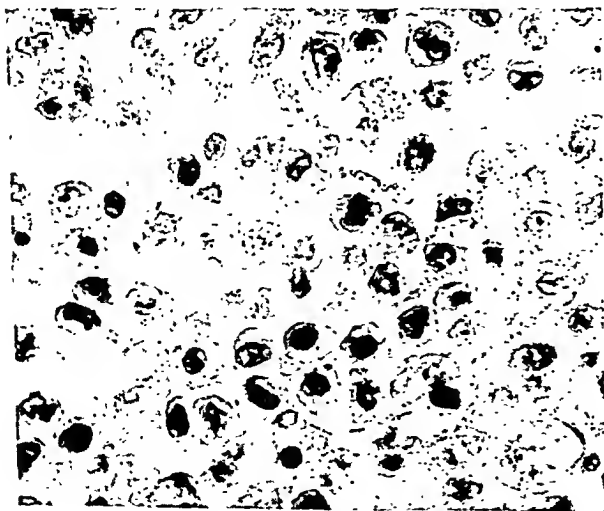


Fig. 167.—*Case 1.* Section of the metastatic growth in the heart ($\times 540$).

At the autopsy very little of interest was found beyond the growth in the right flank already described. This was very soft and had become largely necrotic. The only metastasis that could be found was a lump the size of a marble in the muscle of the right ventricle of the heart. The patient's death was due primarily to cachexia and toxæmia.

Sections from the less necrotic parts of the growth showed an extreme degree of metaplasia of the cells, which, in the absence of other

evidence, it would have been difficult to assign to their true origin (*Fig. 166*).

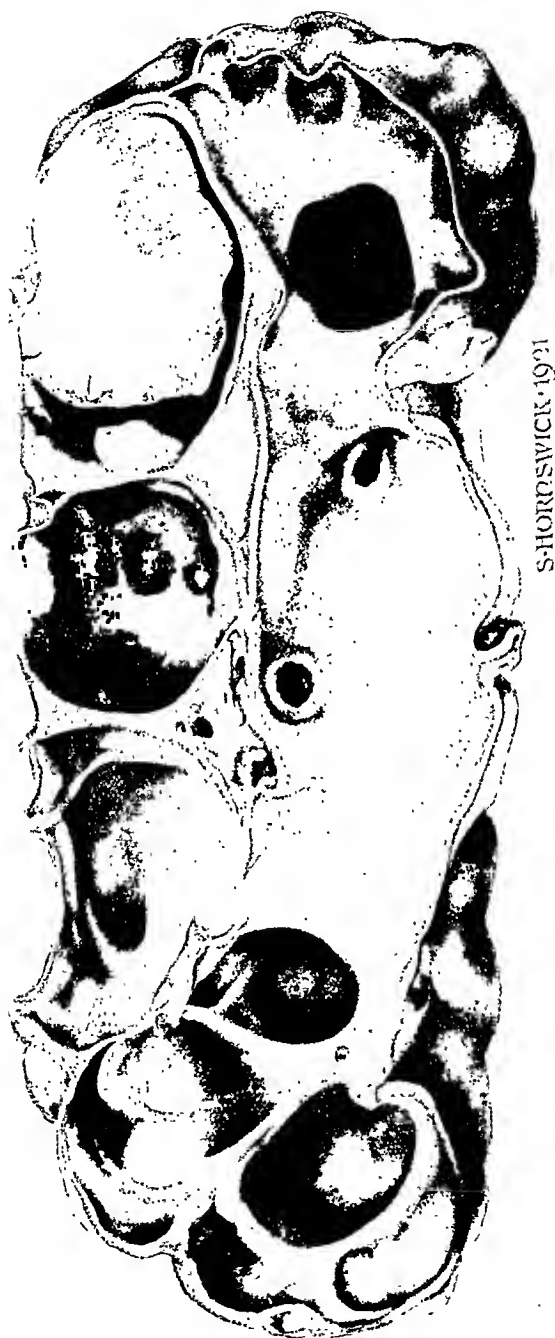


FIG. 168.—Case 2. Mesial section of the kidney, showing large malignant papilloma in a dilated calix near the lower pole.

These cells were of all shapes and sizes, and, but for the absence of any stroma, could not confidently have been designated carcinomatous. A section (*Fig. 167*) of the metastatic growth from the heart showed a more uniform type of cell, but the type was that of a more primitive, rounder cell than was found in the primary growth. In the luxuriant growth on the surface of the body the cells, as already described, had so far departed from their original form that they were believed to be sarcomatous. This observation suggests that some of the recorded cases of sarcoma of the kidney associated with calculus may have been in reality carcinomata, the primary lesion having been, as in the present instance, relatively inconspicuous.

CASE 2.—A night-watchman, age 54, had complained of no symptoms until May, 1921, when he noticed some blood in his urine. This was unaccompanied



FIG. 169.—Case 2. Section of the base of the malignant papilloma of the renal calix ($\times 95$).

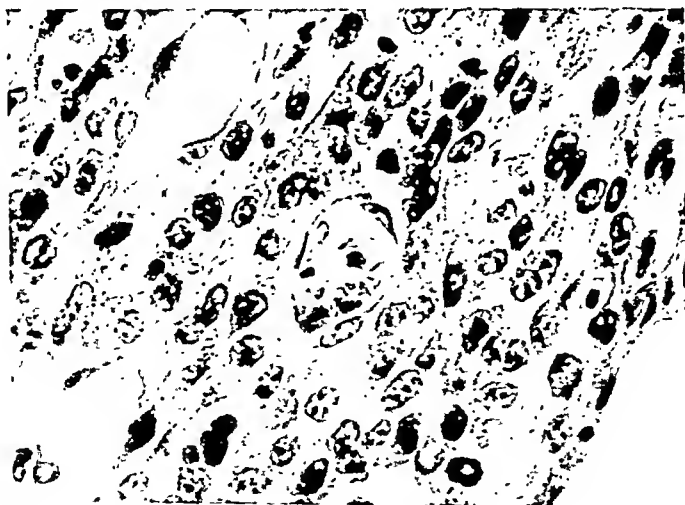


FIG. 170.—Case 2. Same as *Fig. 169*—higher power view ($\times 480$).

by any pain, difficulty in micturition, or increased frequency. In June, 1921, the patient experienced attacks of severe pain in the lumbar region

on the right side. He came to hospital on account of pain, and was admitted on Aug. 15. He was then found to have a large, tense tumour in the left flank, which moved on respiration and was dull to percussion. His urine contained many pus-cells, a few red blood-cells, and many coliform bacilli. A cystoscopy showed that the efflux from the right kidney was normal, but that the efflux on the left side was very infrequent, and that no indigo-carmin was discharged from this side after intravenous injection. The blood-urea content was estimated to be 42 mgrm. per 100 c.c.

The left kidney was removed by Mr. T. P. Dunhill on Aug. 19, but not without difficulty, owing to its enormous size and to the presence of adhesions near the lower pole. The patient made an uninterrupted recovery, and was discharged from hospital, apparently well, on Sept. 10, 1921. His further history is not known, and no reply was received to inquiries made on several occasions during the two following years. The condition found on examination of the specimen makes it probable that he did not survive his operation for long.

The kidney which had been removed was very greatly distended, the cortex being reduced to a thin shell (*Fig. 168*). The pelvis was also greatly dilated, measuring 4 in. by 3 in., and its wall was hypertrophied. For some thirty minutes after removal of the kidney, any stimulus applied to the wall of the pelvis initiated a strong wave of contraction, which spread round the whole pelvis and culminated at the ureteric orifice. The ureteric orifice was small, but the ureter itself appeared to be normal. The gigantic pelvis, as seen in the figure, communicated through a number of holes with greatly dilated calices. These were filled with blood-clot, and in the biggest, situated in the lower pole, was a large papillomatous growth, surrounded by several smaller ones. The capsule of the kidney was missing over the area corresponding to these growths, the wall of the kidney having been adherent to neighbouring structures. Sections through the bases of these growths showed infiltration by cells of transitional epithelium, which had no tendency to keratinize (*Figs. 169, 170*).

In this case, therefore, there was a papillary squamous-celled carcinoma growing in the calix of a kidney affected by hydronephrosis of the congenital type. The ureter was normal, and no aberrant vessel was found obstructing the outflow of urine. Muscular co-ordination was seen to be normal in the renal pelvis, and it seems necessary, therefore, to postulate incomplete relaxation of the ureter itself in order to account for the condition. Whatever the cause of the hydronephrosis may have been, it had evidently been present for many years before the development of the carcinoma, which seemed only recently to have infiltrated through the wall of the kidney to the surface.

CASE 3.—A milk carrier, age 20, had complained of recurrent attacks of pain in his back in the left renal angle, accompanied by hæmaturia. The first attack was in March, 1923, and he had three or four similar attacks during the year. The patient was in severe pain when admitted to hospital on March 7, 1924. His urine contained much blood, and was found to be infected with a coliform bacillus. The left kidney could be felt to be somewhat enlarged, but was not tender. The mucous membrane round the left ureteric orifice was seen to be œdematous. Other investigations led to a tentative

diagnosis of hydronephrosis with hæmaturia being made, and the left kidney was removed by Mr. T. P. Dunhill on March 21.

Both the kidney and the pelvis were much enlarged, the wall of the pelvis being also hypertrophied (*Fig. 171*). The ureter had very much thickened walls, and the lumen was very narrow at the upper end. In the upper part of the pelvis were two chronic ulcers, the larger one being covered with a layer of fibrinous material. A considerable area of the rest of the pelvis was of an opaque whitish colour, apparently due to an early stage of leucoplakia. No abnormal renal artery was found, so that the kidney appeared to be in an earlier stage of the same condition as was found in *Case 2*. Hæmaturia is a not infrequent sign of hydronephrosis even in the absence of any ulceration, though it is not always mentioned in the published accounts of the disease. The patient in the present case was young, but had he not had severe pain as a symptom it seems probable that the lapse of another thirty years might have resulted in the production of a kidney resembling that of *Case 2*.



FIG. 171.—*Case 3*. Mesial section of kidney, showing chronic ulcers in upper part of dilated pelvis and early leucoplakia in the lower part.

All three patients were in the wards of the Surgical Professorial Unit, St. Bartholomew's Hospital, under Professor G. E. Gask, who has kindly allowed the cases to be published. The specimens here described are now all in the museum of the Hospital.

The microphotographs illustrating this article have been made by Miss M. Vaughan, Dunn Laboratory, St. Bartholomew's Hospital.

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SOME OBSERVATIONS ON THE PROGNOSIS IN ACUTE APPENDICITIS.

BY R. J. MCNEILL LOVE, LONDON.

HAVING recently analysed and published in the *BRITISH JOURNAL OF SURGERY* (April, 1923) the result of operations for acute appendicitis at the London Hospital for three years, 1920-22, it appeared that a fuller analysis might reveal some further points of interest; and in order to acquire further data I have included cases of acute appendicitis operated on during 1923—making a total of 2018 cases.*

Table A.—PROGNOSIS REGARDING LOCAL CONDITIONS.

Group I.—Cases operated on *within twenty-four hours* of onset.

NO. OF CASES	RECOVERED	DIED	MORTALITY
221	219	2	Per cent 0·9

Group II.—Cases treated on *delayed* lines.

	NO. OF CASES	RECOVERED	DIED	MORTALITY
Inflammation subsided ..	232	227	5	Per cent 2·1
Unsuccessfully delayed ..	109	102	7	6·4
Total	341	329	12	3·5

Group III.—Cases in which *immediate operation* was performed (including *Group I*).

CONDITION PRESENT AT OPERATION	NO. OF CASES	RECOVERED	DIED	MORTALITY
Inflammation limited to the appendix ..	633	627	6	Per cent 0·9
Local peritonitis ..	467	438	29	6·2
Local abscess ..	347	331	16	4·6
General peritonitis ..	230	183	47	20·5
Total	1677	1579	98	5·8

In my previous article I attempted to elucidate replies to two questions—

* I am indebted to the surgeons of the London Hospital for permission to include in the above series cases which were under their treatment or observation.

"When to operate" and "The best route for drainage". In this paper I propose to consider the prognosis of acute appendicitis with regard to local conditions present at operation, the duration of the attack, and the age of the patient, and I have summarized complications which occurred in this series of cases. The analysis of these groups gives additional support to those who advocate that the treatment of cases of acute appendicitis should receive individual consideration, in contradiction to the popular belief that all cases should be operated on as soon as diagnosed.

Local Conditions at Operation (Table A).—All surgeons are agreed that early cases of appendicitis should be operated on immediately while the infection is still limited to the appendix, that is, during the first twenty-four to thirty-six hours, or the period more accurately defined by the presence of a band of hyperæsthesia above Poupart's ligament, which denotes a distended and therefore intact appendix.

As seen in the above table, the lowest mortality (0.9 per cent) is naturally in cases operated on in this early stage. Then follows the quiescent group with a mortality of 2.1 per cent. This group consists of cases which had passed the period of safety and were then successfully tided over the acute period, and appendicectomy performed after inflammation had subsided. In addition to this, credit must also be given to the delayed treatment for converting many cases of local and general peritonitis into a localized abscess, which carries a lower mortality than either of these two antecedent conditions. Also, in comparing the mortality of *Groups II* and *III*, it must be noted that *Group III* includes *Group I*, i.e., 221 cases in which operation was performed within twenty-four hours. As the delayed group only consists of cases which have passed this early period, in order to obtain a true comparison of the mortality of immediate and delayed operations these early cases must also be excluded from *Group III*. We then find the mortality of cases in which immediate operation was performed is 6.6 per cent, compared with a mortality of 3.5 per cent in delayed cases.

Briefly outlined, the principles of delayed treatment, which were recommended by Sherren¹ as long ago as 1905, are as follows: If, after admission, it is decided that the appendix is perforated, local abscess is present, or general peritonitis has supervened, the patient is placed in Fowler's position, fomentations are applied to the abdomen to relieve pain, and only water is given by mouth. A four-hourly chart is kept, and over 70 per cent of cases subside, and permit of a subsequent clean appendicectomy. This is performed after the pulse and temperature have been normal for a week, or after the complete disappearance of local inflammatory swelling. This interval is usually within ten to fourteen days after admission, during which period the patient is given a fluid diet as soon as he desires such, and the bowels are only moved by an enema if indicated by abdominal discomfort. A word of caution is necessary with regard to the enema: rupture of an abscess has occurred from sudden distention of the lower bowel by a pint of soap and water; hence to reduce local disturbance to the minimum a small glycerin enema is given, which may be preceded by liquid paraffin by the mouth.

During the interval of delay, operation may be required for two reasons.

1. If after twenty-four hours of delayed treatment the pulse and

temperature show no indication to fall, or the patient complains of increasing pain or discomfort. This delay might be expected to influence the prognosis adversely; but figures show that such is not the case, the mortality being 6.6 per cent in cases operated upon immediately, and 6.4 per cent in the unsuccessfully delayed.

2. In certain cases a localized abscess forms which can be allowed to absorb in safety. Occasionally the abscess increases in size and causes marked toxæmic symptoms, in which case it is opened and drained in order to avoid rupture internally or on the surface. As it is very improbable that the appendix can be satisfactorily removed in the case of localized abscess, the drainage can be readily performed under nitrous oxide anæsthesia, and thus the risk and discomfort of the usual general anæsthetic avoided.

The local peritonitis group carries a relatively high mortality—6.2 per cent. Had treatment of this group been delayed, in all probability the majority of them would either have subsided or localized to form an abscess, and in either case the mortality would be substantially reduced.

Cases of general peritonitis subjected to surgical interference carry a notoriously high mortality; in 230 cases in this series the mortality was 20.5 per cent. Marsch,² in an analysis of 9000 cases, found that cases of general peritonitis carried a mortality of 17.5 per cent. Several factors combine to this end, probably the most important being the virulence of infection as compared with the patient's resistance, which is indicated pathologically by the inability of the tissues to form protective adhesions. Again, these cases are usually subjected to operation at the most inappropriate time, a factor which is discussed later.

Table B.—MORTALITY OF OPERATION ON THE DIFFERENT DAYS OF THE ATTACK.

NO. OF DAYS	INFLAMMATION LIMITED TO APPENDIX		LOCAL PERITONITIS		LOCAL ABSCESS		GENERAL PERITONITIS		TOTAL		MORTALITY
	Recor'd	Died	Recor'd	Died	Recor'd	Died	Recor'd	Died	Recor'd	Died	
1	191	1	52	1	20	0	16	1	279	3	Per cent 1.1
2	264	2	61	2	45	2	69	7	439	13	2.8
3	82	2	79	12	123	8	72	19	356	41	10.3
4	21	0	67	9	71	5	26	8	185	22	10.6
5	8	0	22	2	29	0	12	5	71	7	8.9
6	10	1	31	0	32	1	9	3	82	5	5.7
7	4	0	37	1	11	0	2	1	54	2	3.6
8	7	0	19	1	9	0	1	0	36	1	2.7
9	31	0	32	1	15	0	0	0	78	1	1.2
10 or more	133	1	88	4	57	1	3	1	281	7	2.4
Total	751	7	488	33	412	17	210	45	1861	102	5.2

Duration of the Attack (Table B).—This table emphasizes the accepted fact that operations from the third to the fifth day carry a high mortality. The mortality of operation on the first day is almost negligible (1.1 per cent); on the second day it is appreciable (2.8 per cent); from the third to the fifth day it is lamentable, being 10.2 per cent for this period. After the fifth day we find the mortality dwindles as the duration of history lengthens.

The most important factor which determines this high mortality of third to fifth day operations is the resistance of the patient, which at this period is at its lowest ebb. Natural immunity to the infection has been exhausted, and acquired immunity has not yet been established, i.e., the patient is in the 'negative phase'. Unnecessary operative interference at this period is obviously dangerous. Operative manipulations and the exposure of fresh surfaces and planes to infection accelerate the absorption of toxins at the period when the patient is unprotected and least able to deal with them.

Thyroid surgery furnishes an analogous condition; operative manipulation causes temporary hyperthyroidism, and hence a quiescent period is chosen for surgical interference. Again, during the war it was common experience that operations which had to be performed on the necessarily badly infected wounds soon after infliction caused exacerbation of toxæmia.

Delayed treatment allows the resistance of the patient to be re-established, and, even if an abscess forms which can only be opened without removal of the appendix, the mortality of the two-stage operation, i.e., opening the abscess and the subsequent clean appendicectomy, is substantially lower than operation during the dangerous period. Also, if localization is occurring at this period, however gentle operative interference may be, or however carefully packing is inserted, the early protective adhesions are easily separated and general peritonitis may result where only a local infection was originally present.

It is perhaps particularly in cases of general peritonitis that delay is valuable. However little manipulation is attempted in operation during the dangerous period, such manipulation accelerates lymphatic and venous absorption, so that toxins are suddenly absorbed when resistance is at its weakest. The rightly-commended procedure of evisceration and extensive cleansing of the general peritoneal cavity produced acute toxæmia which was euphemized by the term 'shock', and operation in cases of general peritonitis causes toxic absorption in proportion to the amount of interference.

It is well known that cases of ascitic tuberculous peritonitis readily respond to laparotomy, as in these cases intra-abdominal tension is thereby diminished and the lymphatic and vascular channels are encouraged to dilate; hence antibodies flood the affected area. This argument is quite fallacious when applied to cases of acute peritonitis; operation promotes hyperæmia, but there are no antibodies in the blood; the actual result is that toxins are swept away before preparation has been made for their reception.

Cases of acute general peritonitis should be treated on similar lines to an acute cellulitis. In this condition it was formerly the custom to make free incisions into the brawny area, a line of treatment now superseded by conservative measures which allow infection to localize, and if abscesses occur these are subsequently opened. Similarly, general peritonitis should be given the opportunity to subside, and any local collection of pus—e.g., in the pelvis—is drained if toxæmia ensues.

If temporary measures can be successfully employed, the patient's resistance slowly increases; this is reflected in *Table B*, in which it is seen that the mortality decreases as the history lengthens.

Age of Patient (Table C).—It will be seen from *Table C* that the majority of cases of acute appendicitis occur between the ages of 10 and 30, the number in this series being 1290, or 67·5 per cent, occurring during these two decades. Suermondt,³ in a series of 513 cases, found that 41·3 per cent occurred between the ages of 16 and 25. Flint⁴ surmises that in young girls the onset of menstruation may predispose to inflammation of the appendix, and that this is particularly liable to occur at the onset of a period.

Table C.—COMPARISON OF MORTALITY AND AGE.

AGE	DELAYED CASES		INFLAMMATION LIMITED TO APPENDIX		LOCAL PERITONITIS		LOCALIZED ABSCESS		GENERAL PERITONITIS		TOTAL		MORTALITY
	Recov'd	Died	Recov'd	Died	Recov'd	Died	Recov'd	Died	Recov'd	Died	Recov'd	Died	
0-10	27	2	51	1	41	7	49	5	31	15	199	30	Per cent
11-20	132	3	281	2	172	10	107	5	67	22	759	42	13·1
21-30	93	2	189	1	131	6	79	2	39	4	531	15	5·2
31-40	41	3	69	1	57	1	38	1	28	1	233	8	2·8
41-50	32	2	28	0	21	2	41	2	9	3	131	8	3·3
Over 50	4	0	9	1	16	2	17	2	9	2	55	7	5·7
Total	329	12	627	6	438	20	331	16	183	47	1908	110	5·4

With regard to prognosis, the mortality is highest during the first decade. Several factors combine to this end. Minor gastro-intestinal disturbances are common during the early years, being chiefly due to injudicious or illicit diet, and hence an acute appendicitis presenting similar initial symptoms is treated as the minor ailment. Thus skilled advice is only sought after the failure of household remedies, which usually consist of laxatives or purgatives. These drugs merely cause intra-abdominal turmoil, which may effectively prevent the infection from localizing or subsiding, especially when administered after perforation or gangrene of the appendix.

Injudicious treatment by diet and drugs during the early stages of acute appendicitis probably explains the failure to subside in many cases in which delayed treatment is unsuccessful, and frequently the history of such cases supports this view. Children are commonly the unwilling recipients of this energetic treatment, the deleterious effect of which is reflected in the mortality list.

Again, the age and intelligence of young children naturally handicaps them in expressing their symptoms, and this may lead to symptoms being missed in the early stages, and the inadequate history may cause errors in diagnosis, so that inappropriate incisions may be made by the surgeon.

Finally, the resistance to infection is less pronounced at the two extremes of life, which is suggested by the fact that delayed treatment, though valuable, is not as uniformly successful in young children as in those of maturer years.

The second decade carries a higher mortality than the third or fourth, which is again probably due to the fact that erroneous diagnosis and treatment are common during the early stages of acute appendicitis in childhood.

The fifth decade shows a slight rise, and the mortality rapidly increases after 50, due to the lowering of resistance associated with the declining years.

Table D.—COMPLICATIONS DURING ATTACKS (1803 CASES).

Secondary abscess	52	Pulmonary complications—	
Subdiaphragmatic abscess	9	Empyema ..	2
Faecal fistula	74	Pleural effusion ..	1
Phlebitis	7	Pleurisy	3
Intestinal obstruction	19	Pulmonary embolism	1
Parotitis	1		7

(Secondary abscesses were associated on one occasion with a faecal fistula, and on two occasions with intestinal obstruction.)

Total: 169 in 166 patients; i.e., 9.4 per cent of cases presented one or more complications.

Complications (Table D).—I have previously analysed the complications occurring in acute appendicitis, and the addition of the cases for 1923 support the conclusion already drawn. Two points may be briefly mentioned:—

1. The incidental complications occurring in all the cases treated on delayed lines amounted to 6.7 per cent, compared with 11.9 per cent in cases subjected to immediate operation. One also would imagine that sequelæ—e.g., ventral hernia, adhesions, etc.—would show an even greater disproportion in these two groups of cases.

2. Complications following drainage through a gridiron incision still show a marked increase over complications following stab drainage. This drainage may be either suprapubic, or in the loin, or a combination of these two routes.

SUMMARY.

1. When cutaneous hyperæsthesia has disappeared in a case of acute appendicitis, delayed treatment will usually allow the infection to subside.

2. A tentative period of delay does not adversely influence the prognosis, and, combining all cases treated on delayed lines, the mortality, as compared with cases operated on immediately, is nearly halved.

3. Delayed treatment is less uniformly successful at the two extremes of life: in children partly because purgatives are freely administered, and in both cases because resistance to infection is low.

4. The mortality of cases subjected to operation is notoriously high from the third to the fifth days, and especially at this period should delayed treatment be given a trial, so that the patient's resistance may be re-established.

5. Incidental complications in cases operated on immediately are approximately three times as common as in delayed cases.

6. The delayed treatment can only be applied satisfactorily under hospital conditions, when a rigid routine can be strictly enforced. Constant observations must be made regarding alteration of local signs and changes in the general condition of the patient.

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ASEPTIC RESECTION OF THE INTESTINE.

By SETON PRINGLE, DUBLIN.

THE perfect method of performing intestinal anastomosis has yet to be evolved. There are still considerable differences in the details of the technique employed by different surgeons. Indeed, there is divergence of opinion even yet on such an essential matter as the relative advantages of end-to-end, lateral, and end-to-side anastomosis. We are all agreed, however, that the chief danger of the operation lies in the risk of infection, and in the endeavour to overcome this primary risk many efforts have been made to perfect an aseptic technique, and accounts of some of these have appeared in the medical journals from time to time.

Halsted¹ described a method of colectomy which he employed on dogs in forty-seven consecutive experiments without a single failure. He closed the ends of the colon which were to be united by a purse-string suture of silk, and approximated the closed ends by a single row of mattress sutures, completing the operation by puncturing the complete diaphragm thus formed by means of a special guarded knife which he introduced per rectum and which, by means of a long flexible metal handle, he was able to pass up the large intestine to the ileocecal valve if necessary. He has shown that the internal shelf or partial diaphragm which was left by his procedure rapidly unfolded, and that, if unfolding was not complete, at any rate no serious obstruction occurred.

In another paper Highsmith² described a somewhat similar procedure; but he closed the ends of the bowel which he was about to unite by a strand of silkworm gut thrown round the intestine in the groove left by the application of a narrow crushing forceps. The strand of silkworm gut was held in a special 'loop clamp' which is very similar to a nasal polypus snare, the bowel being controlled by the loop of silkworm gut just as the base of a polypus is held by the wire loop of the snare. He then approximated the closed ends, and united them by a row of mattress sutures until only a small gap remained through which the shanks of the loop clamps passed. The loops of silkworm gut in the clamps were then cut and the clamps withdrawn, the lumen of the intestine being thus re-established. The operation was completed by a stitch or two closing the small aperture left by the withdrawal of the clamps.

The work of these two men was experimental, and there is no report of either method having been tried on the human subject; but, in a recent number of the BRITISH JOURNAL OF SURGERY, Fraser and Dott³ reported a method almost identical with that of Highsmith. They carried out a number of experiments on dogs, and, satisfied with the results, successfully adopted the method in two cases of colectomy for cancer of the colon. In their experiments they confirmed Halsted's finding that the internal shelf left

by the operation rapidly unfolded, but in one patient they had subsequent trouble from persistence of this shelf—trouble which they ascribed to excessive infolding of the bowel.

I have recently employed a method similar, but with several differences in detail—differences which I consider important and tending to perfect the method.

STEPS OF THE OPERATION.

1. The bowel is mobilized, the extent to be resected determined, and the main vessel at the apex of the V-shaped piece of mesentery to be excised is ligatured; any other vessels along the lines of the V running up to the points of section of the intestine are secured, and the mesentery is then divided.

2. A large crushing clamp with blades 1 in. wide is applied to the

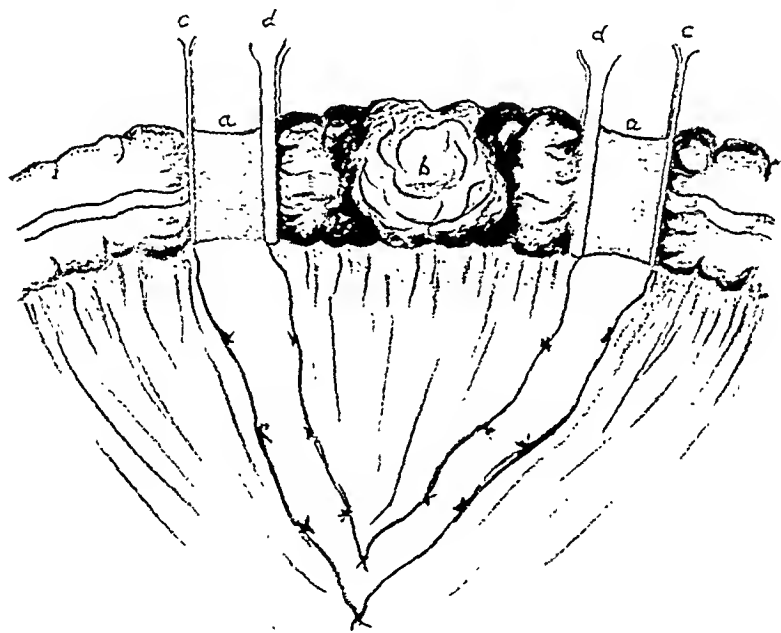


FIG. 172.—*a a*, Crushed segments of intestine above and below the growth *b*. *c c*, Light forceps grasping crushed tissue and controlling the two ends of bowel to be united. *d d*, Heavy clamps controlling the ends of the segment to be removed.

intestine at the point above the growth selected for division (Fig. 172). The crushed portion close up to the proximal end of the intestine is caught with fine but strong forceps (Fig. 172, *c*). The blades of this forceps are $2\frac{1}{2}$ in. long by $\frac{1}{2}$ in. wide, with longitudinal serrations. The forceps is applied across the intestine so that the tip rests just short of the mesenteric attachment—it is important that the tip should not project beyond the margin of the

crushed intestine. When this forceps has been placed, the crushed segment of the bowel close up to the edge of the portion to be removed is grasped in an ordinary heavy straight clamp (*Fig. 172, d*). The intestine is then divided through the crushed portion, the knife, as it were, shaving along the lighter foreeps, and liquid carbolic acid is applied to the cut edge. The intestine at the site for division distal to the growth is similarly treated, the light foreeps being applied to the distal edge of the crushed portion.

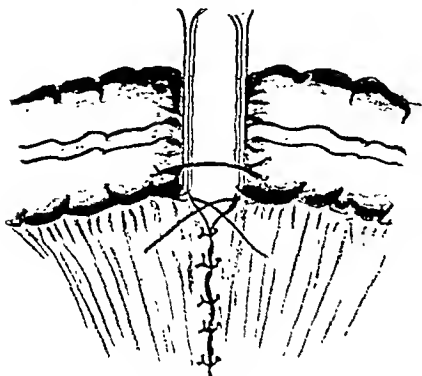


FIG. 173.—The placing of the first mattress suture closing the V gap in mesentery.

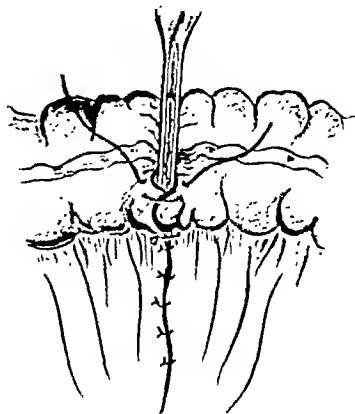


FIG. 174.—Forceps approximated, first mattress suture tightened, [second suture in place.

3. The edges of the divided mesentery are then united up to within an inch of the attachment to the bowel. The two light forceps controlling the ends of the intestine are held in apposition by an assistant. A needle carrying 00 chromic gut is passed through the two leaves of the mesentery bounding the triangular space at the attachment to the intestine, and then picks up the bowel wall $\frac{1}{4}$ in. lateral to the forceps and close to the mesenteric attachment. The needle is carried across, and the bowel in the other forceps is similarly picked up; the needle then emerges through the two leaves of the mesentery on the side opposite its original insertion (*Fig. 173*). This stitch when tightened closes the mesenteric gap, and buries the tip of the forceps in a gutter of infolded intestine (*Fig. 174*). A series of mattress sutures, each penetrating to the submucosa, are then passed, burying the forceps from either side, so that when completed the only place where

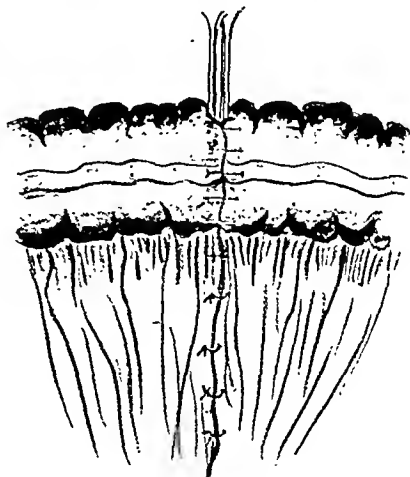


FIG. 175.—Row of mattress sutures completed.

the serous coats of the intestine are not in contact is at the point of emergence of the forceps (*Fig. 175*). Another layer of continuous or interrupted sutures is applied to approximate the intestine further, and, finally, the clamps are loosened and withdrawn and the small gap thus left sutured. When the suture line is completed, if the intestine is picked up between finger and thumb so that one lies above and the other below the line of anastomosis, a free opening will be found to exist between the two segments (*Fig. 176*).

The similarity between the above method and those already reported is obvious. In some details—such as the method of suture—they are practically identical; but there are two points of difference. First, the bowel is divided through a previously crushed portion, so that the mucous membrane is never exposed and the risk of infection is thus reduced to a minimum. Halsted and Highsmith cut through the mucous membrane so that a cuff of it is exposed distal to the encircling ligature, while Fraser and Dott divide the bowel outside the grasp of the crushing clamp. Halsted has shown conclusively that infection of the peritoneal coat round the anastomosis delays, or may even prevent, the unfolding of the internal shelf formed in this method of anastomosis; and so, apart from any risk of gross infection, it is essential



FIG. 176.—Diagrammatic representation of longitudinal section of anastomosis.

that every possible care should be taken to avoid even the slightest chance of contamination. In the second place, I think the use of the clamp as opposed to the use of encircling ligatures lessens the possibility of permanent internal shelf-formation, as the infolding mattress sutures can be placed much closer up to the clamp than to the encircling ligature. Another advantage of my method is that no special instrument such as

Halsted's knife, Highsmith's 'loop clamp', or Fraser's 'ligature guillotine' is needed.

The chief criticism that is likely to be directed against this method is the fact that mucous membrane is not sutured to mucous membrane. The experimental work carried out by those workers already referred to showed conclusively, I think, that suture of the mucous membrane was not necessary either for immediate union or final repair. Schoemaker,⁴ however, employs a technique in which he makes a circular incision round the intestine through the serous and muscular coats and turns back a cuff of these layers, thus leaving a tube of intact mucosa on which he places two small clamps close together, and divides the intestine between them. Having removed the desired segment of the intestine, the two ends still closed by the clamps are approximated, and end-to-end union is made with an inner sero-musculo-mucous and an outer sero-muscular layer of stitches. The controlling clamp is removed as the last stitch of the inner layer is tied, and thus the anastomosis is completed without the lumen of the bowel having been opened during the operation. There seems to me a distinct possibility of infection from very slight errors in his technique. First, in making the circular incision and in turning back the sero-muscular cuff the mucous membrane might

conceivably be opened; and, secondly, in cases where the bowel above the obstruction is dilated and thin, it must be extremely difficult to take up the mucous membrane with the deeper suture without penetrating the lumen, or even producing small tears. It would appear therefore that Schoemaker's method introduces certain complications and risks to gain an object which experimental and clinical work has shown to be unnecessary.



FIG. 177.—Result of barium enema four weeks after resection, demonstrating absence of obstruction. The site of anastomosis is indicated by the arrow.

I have carried out my method in three cases, of which short notes are appended. In each the time of operation was shorter, the hæmorrhage less, and the risk of infection enormously diminished, as compared with other methods. In each the immediate recovery was excellent; none of the patients had the slightest sign of local or general infection, and convalescence in all three was remarkably smooth.

CASES.

Case 1.—A. W., male, age 62. Admitted with subacute intestinal obstruction. After five days' preliminary treatment with purgatives and enemata, the abdomen was opened and a cancer of the iliac colon resected, end-to-end anastomosis by the method above described being carried out. The operation was completed by performing a cæcostomy. Convalescence was quite uneventful, the cæcostomy gradually contracting, and the bowels moving per rectum three weeks after the operation. The X-ray (*Fig. 177*) demonstrates the absence of any obstruction, though the site of anastomosis is indicated.

Case 2.—M. L., male, age 52. Admitted complaining of diarrhœa for past year. The middle two-thirds of the transverse colon were obviously filled with a faecal mass: there was also a hard, nodular tumour to be felt in the right iliac fossa. With purgatives and enemata the colon was emptied, and five days after admission the abdomen was opened. It was then found that there was a cancer of the cæcum, with a second pedunculated tumour of the transverse colon. The small intestine was divided 6 in. above the ileo-cæcal valve, the colon was resected to within a few inches of the splenic flexure, and end-to-end anastomosis of the small intestine to the colon carried out. The bowels moved per rectum on the fourth day, and convalescence was quite uneventful. Microscopical examination showed that both tumours were carcinomatous.

Case 3.—J. J., female, age 52. Admitted with subacute intestinal obstruction. As enemata failed to relieve, cæcostomy was carried out. Twelve days later the abdomen was reopened and a cancer of the splenic flexure resected, end-to-end anastomosis being performed. In this case also convalescence was uninterrupted, apart from the fact that some pouting of the mucous membrane took place through the cæcal opening, and a plastic operation was required for its closure. Following the latter operation the action of the bowels was normal, liquid paraffin being the only aperient needed.

Note.—A fourth successful resection of the colon, with end-to-end anastomosis of the ileum to the transverse colon by this method, has since been performed.

I wish to express my indebtedness to Dr. E. C. Smith for the drawings which illustrate this paper.

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POLYCYSTIC DISEASE OF THE KIDNEYS.

(*Congenital Cystic Kidney.*)

By ROY F. YOUNG, GLASGOW.

THIS disease is characterized by the presence of multiple cysts in the kidney substance. In the great majority of cases both kidneys are affected. That this condition can no longer be regarded as a pathological curiosity is proved by the numerous illustrative contributions on the subject in the medical press within the last fifteen years. The following five cases, seen within the last five years, provide additional evidence.

Case 1.—J. N., male, age 52. Admitted to hospital in May, 1919, complaining of pain in the right flank. For two years he had suffered from a dull, gnawing pain in the right lumbar region, and increasing unfitness for work, but no noticeable loss of weight. After admission a tumour of the right kidney was discovered, and the kidney was removed. This proved to be a cystic kidney. I did not see this patient till five days after operation, by which time uræmic symptoms had developed, with hiccups, drowsiness, and scanty output of urine. The left kidney was enlarged, elastic, and movable. The patient died thirteen days after operation.

A post-mortem examination showed the left kidney to be enlarged and cystic, with little normal tissue between the cysts. There were no changes in the liver, nor any other evidences of developmental defects. Nor was there any history of similar disease in the family.

Case 2.—F. W., male, age 36. Admitted to the Western Infirmary, Glasgow, in January, 1922. Seven years previously, he states, he received a blow on the left flank, which was followed by hæmaturia of six days' duration. Two years later he had another attack of hæmaturia. On neither occasion was there any pain. His next attack was four weeks before admission, when the amount of blood passed was large, and was accompanied by a sharp, stabbing pain in the left side. His previous health was good; the family history negative. A large elastic tumour could be felt in the left lumbar region, but the right kidney could not be palpated. The liver was not enlarged, but the superficial venules over the lower hepatic area were dilated. Urine: 1020, acid, large amount of blood; the microscopic deposit showed red blood-cells only. Blood urea: 41.4 mgrm. On cystoscopic examination the bladder was found to be healthy, the right ureter normal, but blood was coming from the left ureter. Two days later, as the hæmorrhage was increasing, the kidney was exposed from the lumbar route, and a large polycystic kidney, free from adhesions, was found. On account of the hæmorrhage the kidney was removed. The kidney measured $6\frac{1}{2}$ by $3\frac{1}{2}$ in. To the naked eye the normal kidney tissue was replaced entirely by cysts; the pelvis was distended with blood.

After operation the amount of urine passed in twenty-four hours, which had been within normal limits, fell, varying from 10 to 30 oz. He also developed a persistent hiccup which lasted for sixteen days. By the eighteenth day the urine reached normal limits, and when he left hospital, five weeks after operation, it averaged between 50 and 60 oz. Two days prior to leaving hospital the urine was acid, 1018; no albumin or blood; a few hyaline casts were seen by microscope. The blood urea was 54.9 mgrm.

He reported in March, 1922, about ten weeks after operation. He had put on

one stone in weight. At the end of April he was feeling well, but felt an occasional dull aching in the right loin. The lower pole of the right kidney could now be palpated, but was not tender. Urine: 1025, acid, no blood or albumin; passing about 40 oz. in the twenty-four hours. Blood urea: 46.3 mgrm. Reported in March, 1923. Had kept well, was well nourished and was not losing weight. Had been at work for ten months. Lower pole of right kidney palpable, but felt firm, and of normal contour. Blood urea, 38.7 mgrm.; urea concentration, 2.3 per cent; urea concentration factor, 45.

In February, 1924—two years after operation—his health remains good, he is able for full work, is not losing weight, and does not suffer from pain or discomfort. The kidney has not increased in size, and the urine is healthy, about 50 oz. being passed in the twenty-four hours.

In this case it appears reasonable to suppose that the cystic disease was unilateral.

Case 3.—G. E., male, age 36. Admitted to the Western Infirmary, Glasgow, in November, 1922, with a history of occasional attacks of hæmaturia of five years' duration. In June, 1917, while on active service in France, he had his first attack of hæmaturia, for which he was treated in hospital as a case of nephritis. The next attack was in 1919. There were subsequent occasional attacks of hæmaturia, the bleeding lasting for two or three days. In September, 1922, during another attack, the left kidney was found to be enlarged. He has never suffered pain on any occasion. Family history is negative.

On admission, a firm, elastic tumour was present in the left side, occupying the left lumbar and hypochondrial regions, and extending forward into the umbilical region. The tumour moved with respiration, and could be pushed forward from the back, but was not tender. The right kidney was also enlarged, but to a much less degree. Urine: 1016, neutral, small amount of albumin; on microscopic examination of the deposit a few pus-cells were found, but no red blood-cells nor organisms. The amount of urine varied from 60 to 95 oz. in the twenty-four hours. Blood urea, 63 mgrm.; urea concentration test, 1.2 per cent; urea concentration factor, 16. On cystoscope examination the bladder and ureter openings appeared quite healthy. A diagnosis of bilateral polycystic disease of the kidneys was made.

He was readmitted in September, 1923, for examination. In the interval he had been at full work as a platelayer, and had kept well. Both kidneys had increased in size. The blood-pressure was 170, but the heart was not increased in size. Urine:

1010, acid, with a trace of albumin; the deposit showed some pus-cells and triple phosphate crystals, but no blood. The amount of urine in twenty-four hours was low for two days, but this was succeeded by a polyuria of from 80 to 90 oz. Blood urea, 72 mgrm.; urea concentration test, 1.0 per cent; urea concentration factor, 12.5. An X-ray examination showed the diaphragm on the left side to be at its normal level. With a barium enema the descending colon was seen to be pushed well over to the middle line, while the ascending colon occupied its usual position. Readmitted in January, 1924. He had been at his work until a fortnight



FIG. 178.—Case 3. Pyelogram of left pelvis.

previously, when he had to discontinue owing to a gnawing, jagging pain in the left side, which lasted two days but was not accompanied by hæmaturia. A week later he suffered from a complete obstruction of the colon for three days. He has been losing weight. There was an obvious further enlargement of the left kidney, which now reached almost to the umbilicus, and was visible on inspection. The right had remained much as before. Blood-pressure, 160. Urine: 1007, acid; no albumin; triple phosphates, only, found in the deposit. Blood urea, 95.6 mgrm.; urea concentration test, 0.9 per cent; urea concentration factor, 8.4.

Mr. Walter Galbraith kindly undertook the pyelography of the kidneys. That of the left kidney, which is here reproduced (*Fig. 178*), does not show any definite characteristic, while it was found impossible to get any clear shadow on the right side, possibly on account of pressure on the pelvis.

As the left kidney, on account of its bulk, had threatened on occasions to cause



Fig. 179.—Photograph of kidney removed in *Case 4*. Each square of the background measures one inch.

intestinal obstruction by pressure on the descending colon, it was decided to attempt to lessen the bulk of the kidney by operative means. Under local anaesthesia the organ was exposed through the abdominal wall where the tumour was most prominent. This portion of the kidney, at its lower pole, was incised, and about 5 oz. of fluid were evacuated. This fluid had all the appearances of altered blood, and did not contain urine. The edges of the incision in the kidney were sutured to peritoneum, and the cavity packed through this. He made an uninterrupted recovery, but the cavity still requires packing. His general health is good.

On examination of the specific gravity of the separated urines, that from the left—and more extensively affected—kidney was between 1000 and 1005, while that from the right was between 1005 and 1010.

Case 4.—Mrs. B., age 52. Admitted to the Royal Alexandra Infirmary, Paisley, in March, 1923, with a swelling in the left side of the abdomen, which had first been observed two years previously, but had caused neither pain nor discomfort. It had gradually increased in size, and on admission she complained of an aching, dragging pain in the side, which was worse when she was up. There was

some frequency of micturition, small quantities of urine being passed at a time. There was some discomfort after food, with occasional vomiting, increasing anorexia, and loss of weight. The left kidney was enlarged, elastic, and movable, but the right kidney was not enlarged, nor was there any enlargement of the liver. Urine: 1010, acid, with a trace of albumin. In the deposit were present pus-cells, a few red blood-cells, and scanty hyaline and granular casts. Urea concentration test, 2 per cent. X-ray examination was negative, but with a barium enema the descending colon was seen to be pushed inwards towards the middle line. On cystoscopic examination the bladder and ureter openings were seen to be healthy.

At operation the kidney was exposed through the abdominal route, and was found to be cystic. The right kidney was examined by palpation, and appeared to be normal in size, shape, and consistency. The left kidney was removed.

Report on kidney by Dr. Hannay (*Fig. 179*): Weighs 13 oz.; irregular shape, measuring $6\frac{1}{2}$ by 4 in. at upper pole, by 1 in. at lower pole. It is solid in the central part, and cystic at each end. The ureter is not dilated. The renal artery is smaller than normal. On section there is a spherical, encapsulated cyst, 3 in. in diameter, at the upper end, and a sausage-shaped cyst, $2\frac{1}{2}$ by 1 in. at the lower pole, with a small amount of kidney substance in front of each, and a larger quantity between them. There is no dilatation of the pelvis. There are about a dozen smaller cysts in the remaining kidney tissue. There is recent extravasation of blood in the adipose tissue surrounding the pelvis. The fluid in the two large cysts measures 6 oz., and resembles urine.

Report on microscopical appearances (*Fig. 180*): There are a number of small cysts in the cortex and medulla, some of them giving rise to a certain amount of compression of the adjacent renal tissue; these cysts are lined by a single layer of flattened cells. The cortical epithelium shows some degenerative change, chiefly fatty. In places there is a slight increase of interstitial tissue. The blood-vessels are not abnormal.

This patient made an uninterrupted recovery, and left the hospital a month after operation. The urinary output, which had been low, remained so after operation, averaging 20 oz. in the twenty-four hours.

In November, 1923, she was readmitted, complaining of pain in the right side of an aching character, also of frequency of micturition, and a scalding pain during the act. For the past three months she had suffered from headache and defective eyesight, and had noticed a puffiness under the eyes in the morning, and some swelling of the legs at night. The right kidney was enlarged, movable, but not tender. Urine: 1014, acid, with distinct albumin; deposit showed pus-cells and organisms which, on culture, proved to be *B. coli*. She left hospital much improved under treatment with bicarbonate of soda.

In February, 1924, her condition was satisfactory. She was fit to carry on her work, and did not suffer from any pain. Her weight was the same as on previous admission. The kidney apparently had not increased in size, but felt somewhat irregular. Urine: 1004, acid, with a trace of albumin; no pus, casts, or organisms were found. Edema of the eyes was still present in the morning.

In this case it is impossible to say if the right kidney has undergone cystic changes. The enlargement may be due to hypertrophy, but the irregularity is suspicious.

Case 5.—F. M., male, age 42. Admitted to the Western Infirmary, Glasgow, in September, 1923, complaining of attacks of hæmaturia of five months' duration.

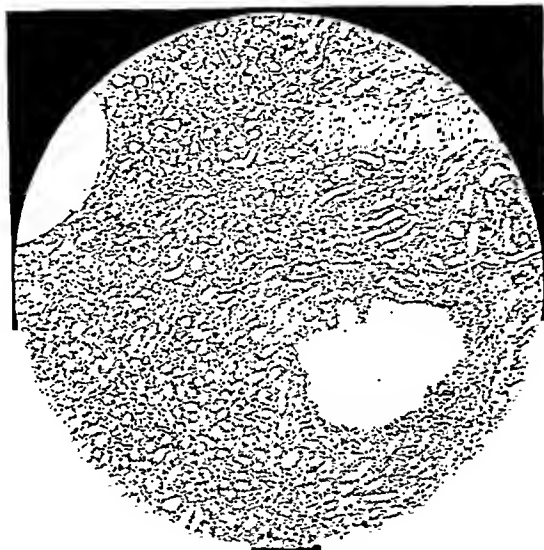


FIG. 180.—Section ($\times 40$) through pyramidal portion of kidney in Case 4, showing one small cyst and portion of another.

In 1917, while in the army, he was treated for nephritis. Apart from this his previous health had been good. The family history was negative. During the last two years he has gradually been losing weight. Five months ago he had an attack of hæmaturia, and since then he has had occasional similar attacks. At no time was there any pain.

Both kidneys were found to be distinctly enlarged, elastic to the touch, and movable, the right kidney being larger than the left. The liver was not enlarged, and other developmental defects were not present. The heart was not enlarged; blood-pressure, 160. Urine: 1016, acid, with trace of albumin; the deposit contained a few pus-cells. The output of urine in the twenty-four hours varied between 40 and 70 oz. Blood urea, 26.4 mgm.; urea concentration test, 1.7 per cent; urea concentration factor, 49. On cystoscopic examination the bladder was seen to be healthy, and urine was coming from both kidneys.

The diagnosis was made of bilateral polycystic disease. I have not been able to get in touch with this patient since.

PATHOGENESIS.

The cause of the formation of these cysts has not yet been established, but several explanatory hypotheses have been advanced. The earliest is that of Virchow, who believed that the condition was due to an intra-uterine obstruction of the kidney tubules by uric acid and lime infarcts. Subsequently he considered that it was due to an intra-uterine papillitis, produced by the uric acid and lime infarcts causing atresia and obliteration of the collecting tubules.¹ His opinion was based on the presence of a round-celled infiltration with accompanying interstitial nephritis and atresia of the papillæ. This explanation is no longer accepted. It has been pointed out that these inflammatory changes are a result, not the cause, of the cyst formation, "a view which is supported by the greater density of the sclerosis round the larger than round the smaller cysts"²; also, as Tow points out,¹ many cases of cystic kidney have been reported in which papillitis could not be demonstrated. Virchow's explanation also fails to explain the developmental defects which are met with, apart from the kidneys, in many of these cases.

The most attractive hypothesis, and the one which receives most support, is that of Kuster, who attributed the cyst formation to an irregular congenital development of the kidneys. The ureter arises as a tubular diverticulum from the Wolffian duct, and from the ureter are developed the pelvis and collecting tubules of the kidney. The uriniferous secretory tubules, on the other hand, are formed in mesoderm, known as the metanephric cell mass. As the collecting tubules grow out into the developing kidney, they acquire connections with the uriniferous tubules.³ Failure to establish a junction between these tubules would result in the formation of cysts within the uriniferous tubules. In the records of the post-mortem examinations of the Royal Hospital for Sick Children, Glasgow, there is an interesting case of congenital absence of one kidney, which would appear to corroborate this view of these cysts:—

No. 387. Male infant. Imperforate anus and hypospadias. On the left side the kidney is in its normal position, but larger than normal. On the right side the kidney is absent, also the ureter and renal vessels. In place of the kidney there is a small cystic mass.

A possible explanation of this may be that the metanephric cell mass was formed, but, owing to the failure of the Wolffian duct process to develop, cystic dilatation occurred in the embryonal structure.

The presence of liver cysts and other congenital maldevelopments associated with many of these cases serves to strengthen this view; also the history of hereditary polycystic disease in some families. If this view of congenital development be correct, it is difficult to understand why the disease should be commoner in the middle-aged than in the young, unless one concludes that the cysts remain latent in youth, and, with the advent of age, commence a gradual increase in size, at a time when more stress is thrown on the kidneys, whose power to respond is diminishing. McKinlay, agreeing with their congenital origin, believes that such cysts may remain quiescent, but that, when present in sufficient quantity to stimulate hyperplastic compensatory change in the renal parenchyma, the lesion will be a progressive one.⁴

A third hypothesis, which has received considerable support, suggests a neoplastic origin of the cysts, of the nature of a multilocular cystadenoma. Brigid and Severi, in 1870, formed this opinion because of an increase in the number of layers of epithelium lining many of the cysts, the presence of epithelial sprouts with surrounding connective tissue from the walls of the tubules, and a pseudo-papilliferous formation on the inner walls of many of the cysts.¹ Against this it has been pointed out that similar epithelial changes were found by Busse to be present in all embryonal kidneys. Also, the changes such as described above are not constant, the epithelial elements frequently being diminished and replaced by connective tissue. McKinlay considers that proliferation of the epithelial lining of the tubules, even attempts to form new, possibly atypical, tubules, may be evidence of compensatory effort by the healthy parenchyma of an organ whose efficiency has been handicapped by malformation.⁴

POSSIBLE ETIOLOGICAL FACTORS.

Certain factors, common to a number of cases cited in the literature, help to throw some light on this condition.

Heredity.—It would appear to be unusual to find a family history of polycystic disease, but there are undoubted authentic cases on record. Eisendrath⁵ found one family in which five members had this disease. Towrites Dungar for several examples; Virchow's case of four children of the same mother in all of whom polycystic kidneys were found; five children of another mother; a father, son, and nephew; and a father, son, and sister, with symptoms in other children of the same family.¹

Age.—Clinically the disease is met with at two periods of life—in infancy and middle life. The occurrence in infancy is rare, and it is seldom found between infancy and twenty-one years of age. In the post-mortem records of the Royal Hospital for Sick Children, Glasgow, since 1915, out of a total of 1411 cases, there is only one case of polycystic disease of the kidneys, unless the one mentioned above is included (No. 387).

No. 748. Male, age 41 weeks. The left kidney shows congenital cystic malformation. It is increased in size to that of an adult kidney, and is converted into a mass of thin-walled cysts with clear or dark-coloured contents, and no trace of intact kidney substance is found. The right kidney, liver, and spleen are healthy.

Ballantyne mentions a case in which delivery of the child at birth was obstructed by a renal tumour of this nature.⁶

Sex.—It is generally agreed that this disease is commoner in females than males. In the cases reported here, four were males and one a female.

Other Congenital Deformities.—There are numerous examples where polycystic disease of kidneys is associated with other congenital deformities. Cysts in the liver are not uncommon; Moschowitz⁷ estimates their association as 19 per cent, and Eisendrath⁵ as 18 per cent of cases. Other deformities which have been noticed are hare-lip, cleft palate, spina bifida, meningocele, hypospadias, and cardiac defects. Ballantyne quotes a case of associated hydrocephalus,⁶ and Thomson-Walker one of horseshoe kidney. In my cases no associated deformities were discovered. In the post-mortem reports of the Hospital for Sick Children, mentioned above, though there are several cases of horseshoe kidney, in none of them was there cystic disease.

Bilateral Disease.—It is the exception to find the disease confined to one kidney. Kidd,⁸ in collecting 149 cases from the literature, found that 9 were unilateral—6 on the left side and 3 on the right.

PATHOLOGY.

The general naked-eye appearance of the kidney, in the majority of cases, is now well recognized. The kidney retains more or less its normal shape, but is enlarged, in some cases enormously so. The normal kidney tissue appears to be replaced entirely by numerous cysts of variable size, giving an appearance of what has been described as 'a bunch of grapes'. In other cases, such as *Case 4*, a considerable area of normal tissue is retained, which, however, shows numerous cysts under the microscope. To the naked eye this specimen (*Fig. 179*) approaches more closely the condition described as 'large, solitary cyst' of the kidney. It is very doubtful, however, whether the solitary cyst of the kidney should be differentiated from the polycystic kidney; in the majority of cases the presence of other cysts in the kidney will be found, and the origin of the cysts is probably the same in both conditions.

The fluid contents of the cysts are not distinctive. The fluid is a clear straw colour, unless there has been hæmorrhage into the cyst, when it becomes blood-stained or dark brown. Albumin, urea, and various salts are present.

The walls of the cysts are lined either by columnar or flat epithelium. In some cases this epithelium shows proliferation, at times having the appearance of intracystic papillary growths; in other cases, such as shown in *Fig. 180*, this proliferation of epithelium is absent. In the early stages, as seen in this same section, the neighbouring renal tubules are healthy, and there is little increase of interstitial tissue. With the increase of the cysts there is corresponding increase in the interstitial fibrous tissue, with pressure on, and gradual disappearance of, the renal tubules.

SIGNS AND SYMPTOMS.

By some authors three stages of the disease are distinguished: the latent; the second stage, when the tumour is present; and the uræmic. The latent period is variously given as from three to ten years. If the congenital

theory of the causation be accepted. the length of the latent period must necessarily be that of the age of the patient at which the first sign of disease was established. The first sign by which disease is detected is said to be the presence of a tumour. Of the five cases here reported, however, in three the first evidence of disease was hæmaturia, all three of whom were males. In the detailed reports of cases which I have come across, this fact seems to be borne out, that in men the first sign is hæmaturia, in women tumour. The possible explanation may be that, in women, a transient hæmaturia may be more readily missed, or may be attributed to other causes.

Premonitory Symptoms.—A careful investigation into the history of each case will generally furnish some evidence of renal insufficiency prior to the onset of hæmaturia or the discovery of a tumour, such as headache, nausea and loss of appetite, with increasing unfitness for work. Some patients have recognized a progressive loss of weight.

Tumour.—Only by the discovery of a renal tumour is there any likelihood of a diagnosis being established. A bilateral enlargement of the kidneys makes the diagnosis practically certain. In the vast majority of cases the disease is bilateral, but one kidney is always in a more advanced stage than the other, in which it may not be easy to detect enlargement. In a few cases the disease is unilateral. The tumour feels elastic, but not fluctuant, and in some cases the irregular cystic protrusions on the surface may be detected. The kidney is not fixed.

Pain.—This is not a constant feature, only about one-half of the cases complaining of pain. It is felt in the lumbar region, and is commonly of a dull, aching character, seldom sharp or stabbing.

Hæmaturia.—According to some writers, hæmaturia is comparatively infrequent. Thomson-Walker, quoting Luzzato, puts it at 16 per cent, while Pousson found it in one-third of the cases.⁹ It is probably much more frequent than this. In four of my five cases it was present. The hæmaturia is intermittent, painless, and not severe. There may be long intervals between attacks—as long as two years elapsing in one of my cases. Renal colic, due to clots, is conspicuously absent. In a few cases the hæmorrhage may be very severe, as in *Case 2* reported here. In one case, reported by Rolando,⁹ the hæmorrhage, which lasted two weeks, was so severe that the bladder was distended with clot; and Eisendrath⁵ states that the hæmaturia may be so severe as to cause death.

Other Urinary Changes.—The character of the urine is that of chronic interstitial nephritis, with a low specific gravity and an acid reaction. Microscopic examination of the sediment may show a few hyaline or granular casts; red blood-corpuscles and pus-cells are not infrequently present. In the majority of cases, polyuria is present until the late stages of the disease, but this is not always so. There is little difference in the urine from the two kidneys, but Fullerton¹⁰ has recently drawn attention to an increased diuresis with lower specific gravity in certain cases of renal disease; in two cases of bilateral cystic disease he found that in one the disease was more advanced on one side, and that the specific gravity of the urine from that side was lower. This is also true of *Case 3*.

Renal Efficiency Tests.—There is not sufficient evidence as yet upon

which to form a definite opinion on this much-debated question. Of my cases, only one, *Case 3*, has had the blood urea, the urea concentration test, and the urea concentration factor adequately worked out. Other renal efficiency tests have been discarded as unreliable. In this case the failing renal efficiency is corroborated by the tests. *Case 2*, according to the tests, developed an improved renal efficiency after nephrectomy.

X-ray Signs.—The ordinary X-ray plates of the renal regions have not, in my experience, proved of any assistance in the diagnosis of this condition. The method of showing up the kidney by the introduction of oxygen into the surrounding tissues would doubtless be of assistance, but it is a method one would hesitate to employ in this condition. A barium enema will show if the colon is displaced towards the middle line, but where this is present the kidney can be palpated readily.

Rolando⁹ claims that, in cases where the right kidney is enlarged but it is difficult to define the condition of the left kidney, X rays will show the presence of an increase in size, "The left kidney, when increasing in size, in place of growing downwards towards the iliac region, as occurs with the right kidney owing to the resistance of the liver, enlarges upwards and displaces the diaphragm upwards, so that the lowest border of the left lung, instead of corresponding with the level of the tenth rib, may lie at the level of the ninth, eighth, or even seventh rib". This was a well-marked sign in two of his cases, in one of which it was corroborated at the post-mortem examination. Since reading his article I have investigated this in two cases, but in neither was the level of the diaphragm raised, though in *Case 3* the left kidney was greatly enlarged.

Pyelography.—Braasch¹¹ states that the pyelograph will identify the cystic nature of the tumour in over half the cases, "The pelvic outline of bilateral cystic kidney is characterized by flattening of the calices, giving a general oval contour to the pelvis, in contradistinction to the retracted calices of the malignant tumour. Occasionally, however, a retraction of the calices may also be found with the bilateral cystic kidney, but it is then broad and open and not slit-like or narrow". Eisendrath has not found pyelography of much assistance. In the only case of those reported here in which pyelography was undertaken, nothing distinctive was found.

Cystoscopic Examination.—This is only of value by reason of negative findings. The bladder and orifices of the ureters are healthy in appearance. In the event of hæmorrhage, of course, the affected side will be discovered.

Compression by Tumour on Surrounding Structures.—This has only been noticed in one case here (*Case 3*), where pressure caused obstruction of the descending colon. Rolando⁹ quotes several authors who cite cases where the renal tumour caused obstruction of the ascending or descending colon; also a case of Glaser's where pressure on the common bile-duct resulted in death from suppurative cholangitis.

Cardiovascular Changes.—These are dependent on the associated chronic interstitial nephritis, but may be present in infancy, as in Tow's case¹ of a boy six weeks of age with great hypertrophy of the left ventricle. In Rolando's six cases a transient hemiplegia occurred in three; and in McKinlay's case⁴ the patient, age 30, was admitted with a hemiplegia.

advanced arteriosclerosis of the aorta and vessels being found post mortem. It is common to find the blood-pressure higher than normal.

Presence of Other Congenital Defects.—These were not present in any of my cases, but they have been observed by many writers and may help in arriving at a diagnosis.

Uræmic Symptoms.—These occur in the terminal stage of the disease, and are common to all advanced renal diseases.

TREATMENT.

It is now universally agreed that operative interference, nephrectomy in particular, should be avoided in this condition. *Case 1* offers sufficient proof. In the few cases where the disease is unilateral, nephrectomy would be the correct treatment, but absence of enlargement of the other kidney—even when examined by intra-abdominal palpation, as in *Case 4*—is no proof that a latent cystic condition is not present. In *Case 2* I had to resort to nephrectomy because the patient's life was endangered by hæmorrhage. From the subsequent history of this case it would appear that the disease, very fortunately, was unilateral.

Apart from nephrectomy, less radical operative proceedings have been carried out. Fixation requires but passing mention. Rovsing has found puncture of the cysts to be of value in relieving pain. Thomson-Walker writes that nephrotomy with evacuation of the large cysts has been performed for pain, and may be tried in anuria. Marion¹² has found a modified form of decapsulation successful for the relief of pain in three of his cases. The capsule is adherent to the walls of the cysts, but decapsulation may be carried out by snipping off the capsule with scissors, thus opening up the superficial cysts, any outgrowths from the walls of which are also removed. Balfour¹³ carried out similar treatment in two cases with the idea of reducing the bulk of the kidney. In both cases drainage was provided for but proved unnecessary. While such treatment cannot be regarded as curative, it suggests a reasonable procedure for the relief of renal tension, as evidenced by constant aching in the lumbar region, and anuria; also in cases where the actual bulk of the kidney may be causing obstructive pressure on neighbouring organs. As a general rule, however, operative treatment should be avoided, and the patient should be treated on the same lines as in chronic interstitial nephritis.

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WHITE MYELOMA OF THE RADIUS.

By T. H. BURLEND and D. J. HARRIES, CARDIFF.

THIS case is interesting clinically as it shows that in children a graft of dead beef-bone gives much the same result as a living autogenous graft.

The patient, a girl, age 9, fell on her right arm in November, 1921, and was treated for a Colles's fracture; but as the swelling above the wrist

did not subside, she was sent in January, 1922, to the out-patient department of the Royal Infirmary. Radiographs (*Fig. 181*) taken on Jan. 25 show the myeloma involving the lower third of the radius. The growth extends downwards almost as far as the epiphysial line, and has actually penetrated its bony shell and invaded the periosteum in two places.



FIG. 181.—Radiographs of the right lower forearm, anteroposterior and lateral views. At *x* and *y* the myeloma has perforated the thin bony shell.

OPERATION.

On Feb. 3, 1922, the lower portion of the radius was removed, leaving the epiphysis intact. The periosteum was left *in situ*,

except at the two points where it had been invaded by the growth. A bone-graft of the size and shape shown in *Fig. 182* was cut from an ox tibia the day before the operation, and boiled for half an hour before insertion. The upper end was pushed into the medullary cavity of the radius, as shown in the illustration, and the periosteum was sutured round the graft. The arm was bandaged on a splint until the skin sutures were removed. It was then put up in plaster. *Fig. 182* shows the graft *in situ* on the second day after the operation. Radiographs taken respectively two, four, and fifteen months after the operation are shown in *Figs. 183, 184, and 185*. *Fig. 185* shows the graft completely absorbed and the radius restored. The radius is not growing at the same rate as the ulna, and this accounts for the radial deviation of the hand.

The patient was encouraged to use the fingers and thumb from the start, and the plaster splint was discarded three months after the operation.

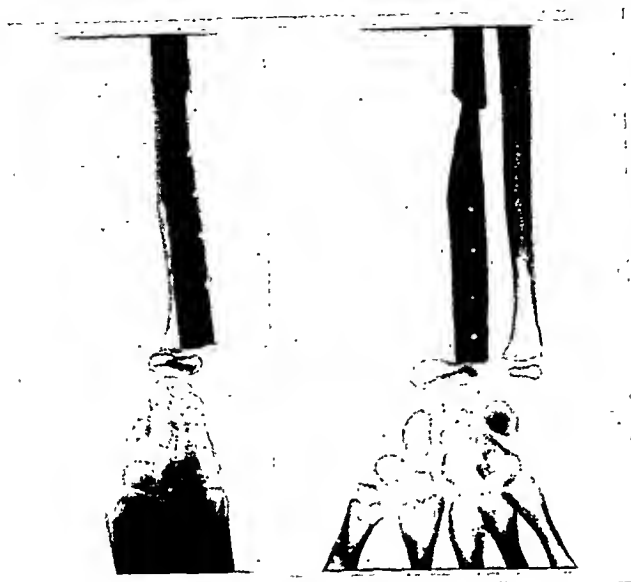


FIG. 182.—Radiographs taken two days after the operation. The somewhat pointed upper end of the bone-graft is visible in the medullary cavity of the radius.



FIG. 183.—Radiographs showing the condition two months after operation. A marked formation of callus has occurred, and the graft is undergoing absorption.

Movements were very little affected at any time, and now, in spite of the radial deviation of the hand, are practically normal. It may be found necessary to remove a part of the ulna to compensate for the slow growth of the radius; but at present it is doubtful if the functional value of the arm could be improved by any operative treatment.



FIG. 184.—Radiograph of the lower forearm four months after operation. Note the extensive callus. The remains of the bone-graft are darker in appearance than is the newly-formed bone.

MICROSCOPIC APPEARANCE.

Our histological examination deals with: (1) *The structure of the tumour itself*; (2) *The boundary zone between tumour and bone or tumour and marrow*; and (3) *The marrow beyond the myeloid expansion*. We shall describe the histological features of these regions separately.

1. Histology of the Tumour.—The growth appears to replace the normal marrow; it consists of spindle cells each with an oval or elongated nucleus, and exhibits here and there throughout the myeloma, particularly numerous near the periphery, large giant cells. In the ordinary red myeloma the colour is explained by the presence of hæmorrhagic extravasations of large size and regions highly vascularized. In the white variety, extravasated blood and vascularized areas are of less frequent occurrence. The concentration of the spindle cells is not uniform, a fasciculated



FIG. 185.—Radiographs taken fifteen months after operation. The regenerated lower third of the radius exhibits radial deviation. The bone-graft has disappeared entirely.

appearance being observable; in a groundwork of loosely scattered cells there appear to be areas of closely-packed spindle cells usually surrounding giant cells: the probable explanation being that spindle cells arise in the dense areas and invade those where there are few cells or none. No signs of mucoid degeneration are observable. Megakaryocytes having a typical annular nucleus, and myelocytes normally present in marrow, are absent. Although the marrow is entirely replaced, there are still some bone trabeculae to be seen. Many of these show necrotic changes. The trabeculae are the remains not only of the spongy bone at the end of the radius but also of the perimedullary bone, the absorption of which keeps pace with the growth of the tumour. There is still a shell of bone, perforated in places, around the myeloid growth beneath the periosteum. A description of a white myeloma has been given by Stewart.¹ The tumour which he describes is also at the lower end of the radius. With most of the histological details given by him we are in agreement, although we consider that the tumour is not a mixed-(mainly spindle-) cell sarcoma as stated by him, but is composed entirely of giant cells and spindle cells, 'small or round cells' being absent. It is probable that what we conclude are spindle cells cut transversely were described as 'mixed' cells by Stewart. This conclusion is supported by the observation that where bundles of spindle cells are cut longitudinally no cells resembling 'small cells' are visible. Hence the accounts of a myeloid sarcoma (or giant-cell sarcoma)—not necessarily of the white variety—given by Macallum² and Ewing³ more closely coincide with our interpretation of the structure of the tumour.

Cytology of the Spindle Cells.—The cells which form the bulk of the tumour vary in size and shape. In some regions they are elongated and arranged in bundles, and in these the nucleus is also elongated and often stains deeply; in other regions the cells are shorter and the nuclei oval. In all cases the nuclear membrane is well defined, and within the nucleus are two prominent karyosomes as well as scattered granules of basichromatin. The nuclei vary in length from 11 to 16 μ and in width from 3 to 6.5 μ . We observed a great similarity in the nuclei of the spindle cells, osteoblasts, osteoclasts, and giant cells; in some cases the spindle-cell nuclei are more elongated, and in other cases they appear swollen; but with respect to nuclear membrane, karyosomes, and chromatin particles there is little or no difference. It has already been mentioned that blood extravasations and vascular areas are present in both grey and red varieties of myeloma, but especially in the latter. Some extravasations and blood-vessels contain blood only, others are being invaded by spindle cells. That a migration of spindle cells occurs from the tumour into the vessels and extravasations, and not in the reverse direction, is clearly indicated in our sections. Of these invading spindle cells, those nearest the margin of the blood-spaces closely resemble the ordinary cells of the myeloma; those which have penetrated into the spaces have more elongated, thinner, deeper-staining nuclei and fusiform outline. Some others are rounded or angular.

Giant Cells.—Unquestionably the most interesting elements in the myeloma are the giant cells. These are found throughout the tumour, but are very numerous near the periphery. Where the spindle cells are most plentiful and

concentrated, viz., in the deeper parts of the myeloma, the giant cells are rare. As we have already stated, those giant cells present within the myeloma are usually surrounded by fasciculi of densely-packed spindle cells. Typically the cytoplasm of the giant cell is markedly eosinophil and counterstains readily with eosin; thus the giant cells contrast with spindle cells, the cytoplasm of which is not eosinophil in reaction. This property is not constant, however, and the cytoplasm of some giant cells shows gradations in colour from intense

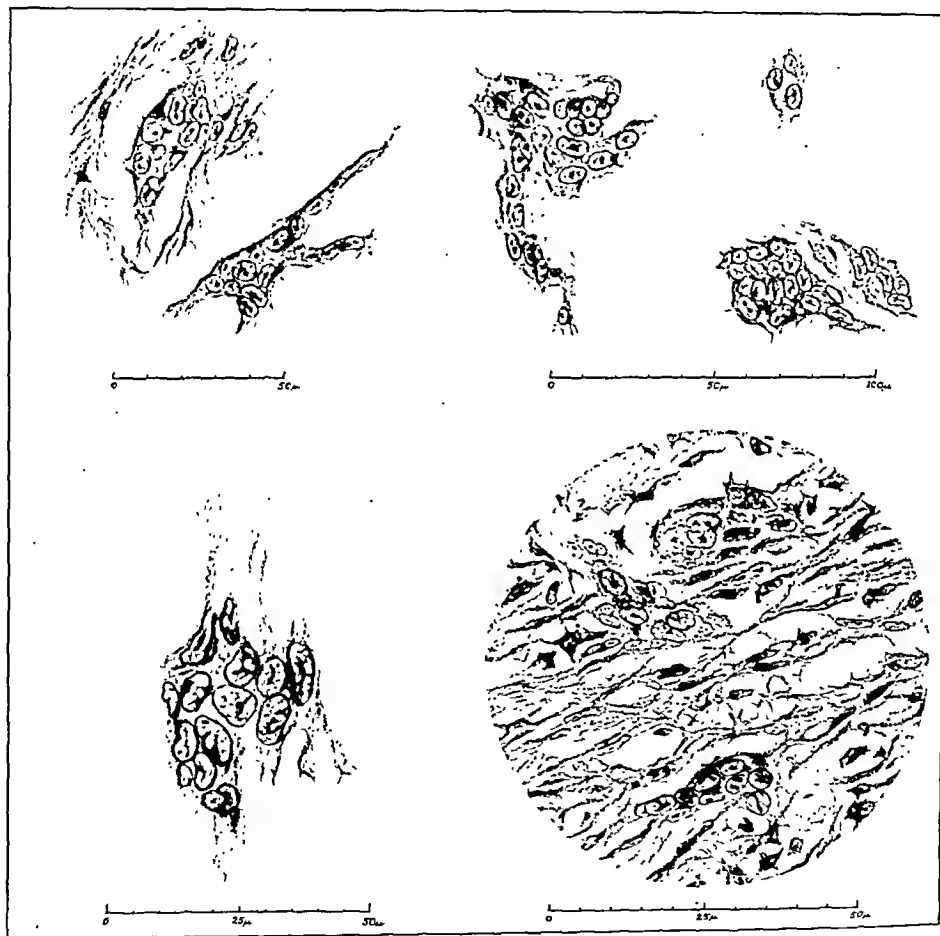


FIG. 186.—Giant cells of the myeloma drawn under high power. There is great variation in size, shape, and number of nuclei. The nuclei of some spindle cells shown in the lower right-hand figure resemble the giant-cell nuclei.

pink to that assumed by the cytoplasm of the spindle cells. The number of nuclei present in the giant cells varies considerably (see Fig. 186), from two or three up to twenty-four and more. As we have counted at least twenty-four in some cells it is safe to conclude that this number is greatly exceeded in many cases, when it is remembered that we are examining thin sections and that some giant cells attain dimensions greater than the thickness of a section.

The nuclei of the giant cells so clearly resemble those of the spindle cells, both in the possession of well-defined nuclear membrane and two karyosomes, and also in size, that we have measured a great many for comparison. They average about $13\ \mu$ in length and $5\ \mu$ in diameter, though some few very elongated nuclei attain a length of $18\ \mu$. As stated above, the spindle-cell nuclei vary in length from 11 to $16\ \mu$, and in width from 3.5 to $6.5\ \mu$. There is the same variation in the outline of the giant-cell nuclei (from oval to spindle form) as occurs in the spindle-cell nuclei.

The size and shape of the giant cells vary as much as does the number of their nuclei. The giant cells with two or three nuclei are only distinguishable from spindle cells by the multinucleate condition, their nuclei being similar and their cytoplasm not eosinophil (*Fig. 187*). In very many cases the giant cells have long processes in which nuclei

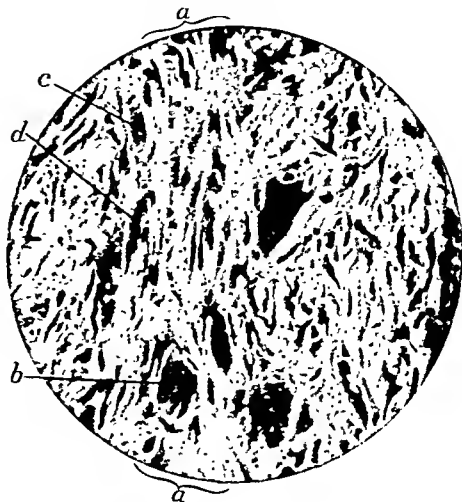


FIG. 187.—A portion of the myeloma containing giant cells. *aa*, Fasciculus of spindle cells produced from the giant cells shown. The one *b* presents a stage of fragmentation; another (*c*) is still smaller; while that at *d* is difficult to distinguish from a group of spindle cells.



FIG. 188.—Two giant cells highly magnified. Note the curious arrangement of the nuclear chromatin in the cell on the left.

with resting nuclei, there are a few—presumably giant cells—with nuclei

(one or more) are present (*Fig. 186*); often these processes, or a considerable portion of the margin of a giant cell, merge imperceptibly into the surrounding spindle cells, so that it is difficult or almost impossible to define the margin of the giant cell. Some giant cells occur in groups, the cells in some cases being so closely contiguous that we have reached the conclusion that the appearance indicates a fragmentation of a giant cell into smaller cells (*Figs. 186 and 187*). Vacuoles (one or more), some containing leucocytes, are visible in many of the giant cells. Sections stained with Leishman or Giemsa clearly demonstrated the phagocytic character of these giant cells, red as well as white corpuscles having been ingested.

In addition to the giant cells

exhibiting karyokinetic changes such as are usually associated with protozoa (*Fig. 188*). The nuclei of the cell to the left side of *Fig. 188* appear to have a nuclear membrane with chromatin attached to it. To the right side of *Fig. 188* the resting nuclei of a giant cell are shown for comparison. Howard⁴ has described giant cells with nuclei which show protozoan characters. We do not propose to deal with the significance of these nuclear appearances until we have further investigated them.

Another interesting variety of multinucleated cell is depicted in *Fig. 189*. The cytoplasm is strongly eosinophil, and the nuclei (eleven of which can be seen in the figure) are much smaller than are those of the ordinary giant cell (3 to 4μ), and moreover stain intensely and uniformly. The microphotograph is of a cell magnified to the same extent as the giant cells seen in *Fig. 188*. We are disinclined to believe that a cell such as the one shown in *Fig. 189* is a giant cell in the pyknotic condition.

Beyond a brief reference to these cells, which may have an important rôle in the etiology of the tumour, we defer consideration of their significance until we have examined additional material.

Giant cells are numerous in the neighbourhood of blood-spaces; but not frequently, in fact rarely, do they appear in the vessels or extravasations. Where spindle cells are invading blood-spaces the giant cells are usually small, and most probably fragmenting to give rise to spindle cells. We have seen nothing to indicate that the giant cells have an angioblastic origin, and no evidence that the giant cells are brought to the tumour in the blood-stream.

2. Histology of the Region between the Myeloma and Subperiosteal Bone or Bone-marrow.—In this region, marked *q* in *Fig. 190*,



FIG. 189.—A multinucleate cell in the myeloma with small deeply-staining nuclei and eosinophil cytoplasm. A portion of the latter (*m*) containing two nuclei is becoming detached from the main mass. Another uninucleate cell probably derived from the large cell is seen out of focus at *n*.



FIG. 190.—Longitudinal section of radius including the lower end of the myeloma (*p*), the intermediate zone (*q*), and the normal marrow (*x*).

there are for the most part numerous blood extravasations in which are seen, in addition to the formed elements of the blood, a great many giant cells or osteoclasts. We use the terms synonymously, because there is no structural character which can be applied whereby the giant cells of this tumour may be distinguished from the numerous osteoclasts also present. With regard to variability in dimensions, contour, and staining reaction, and the number, size, shape, and structure of the nuclei, we find no marked difference between giant cells and osteoclasts; only in cases where a multinucleated cell was in close relation to the bone, e.g., in a Howship's foveola, could we with certainty consider the cell as an osteoclast and not a giant cell. It follows therefore from this last statement that the giant cells in the myeloma may be osteoclasts which have ceased to function as bone-destroyers. Our observations on this point have led us to conclude that the giant cells in a myeloma of the epulis type are, or are derived from, osteoclasts.

In the zone between bone and tumour there are in places bone trabeculae surrounded by numerous, apparently normal, active osteoblasts; in other places osteoclasts are engaged in destroying the bone which the osteoblasts are producing (*Fig. 191*). There is no doubt that the bone trabeculae and the subperiosteal bone are removed by osteoclasts which are not only abnormally large but also abnormally numerous, the subperiosteal bone becoming first cancellous and later reduced to trabeculae ever diminishing in size. Owing to the progress of the myeloma, these trabeculae become incorporated within it, and later undergo necrosis. Since the

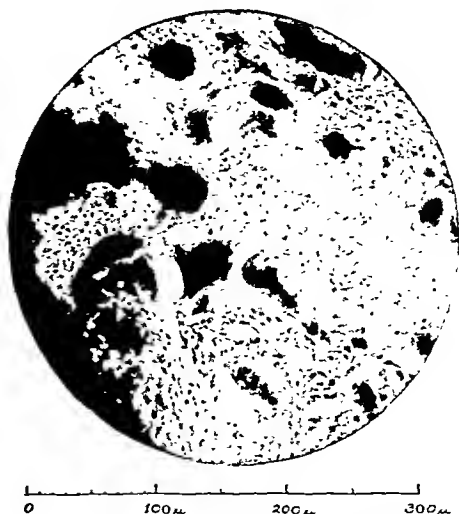


FIG. 191.—A portion of the intermediate zone between myeloma and bone showing the numerous osteoclasts or giant cells. On the extreme left is the bone (black).

osteoclasts are not numerous in the normal marrow adjoining the tumour, and are in our opinion not carried to the tumour by the blood, the most reasonable assumption is that they are formed in great numbers at the boundary between bone and tumour. The nuclei of the osteoclasts vary between 11μ and 8μ ; those of the osteoblasts also range from 8 to 11μ in length. Erythrocytes in these sections are about 6μ in diameter, so the measurements quoted above are probably somewhat lower than those for the fresh unfixed cells. The close similarity in size and structure which exists between the nuclei of osteoblasts and osteoclasts favours the view that the latter are produced by a fusion of the former. The possibility of osteoclasts being derived from marrow is more than doubtful, since there are no tissue-cells in marrow with nuclei at all comparable with those of the osteoclasts. Some trabeculae in this region are covered with osteoblasts,

which in places appear to be undergoing fusion. The change which is occurring at the boundary of the tumour is not apparently due to a deficiency of osteoblasts, but to a disproportionately large number of osteoclasts. Furthermore, many of the osteoclasts in this region are surrounded by spindle cells, and in some cases the former appear to be fragmenting to give rise to the latter.

In the region marked q' in *Fig. 190*, where growth is proceeding towards the epiphysial line, an invasion of the marrow by giant cells and spindle cells is observable, so that beyond the myeloma towards the marrow there is an intermediate or boundary zone consisting of giant cells, spindle cells, marrow elements, and blood. Beyond this again normal marrow is found.

3. Histology of the Marrow beyond the Boundary Zone.—There is nothing noteworthy about the marrow beyond the intermediate zone.

DISCUSSION.

It is probable that a myclloid sarcoma is produced by the formation in abnormal numbers, by the fragmentation later, of osteoclasts which remove the bone very quickly; in consequence the bone becomes thinner and thinner until it (and the periosteum overlying it) is pierced, and the tumour-cells invade neighbouring tissues. Radiographs of the lower third of the affected radius demonstrate the thin shell of bone surrounding the growth: the diameter of the diaphysis in this region is distinctly greater than that in the normal diaphysis (*Fig. 181*). This increase can only be accounted for by supposing (1) that subperiosteal bone is deposited abnormally quickly beneath the periosteum, and (2) that the bone nearest the marrow cavity is absorbed or destroyed even more quickly by irregular osteoclastic activity.

The transitional zone affords most evidence of the probable origin of the tumour, since histologically it differs less from the normal than does the myeloma; in this zone the abnormal features are the excessive number of osteoclasts, the presence of spindle cells (not as concentrated as in the myeloma, but anticipating the condition of the latter), and the reduction in the number of fat-cells and other constituents of marrow. Perhaps the condition which is primarily responsible for the excessive formation of osteoclasts is the chief, if not the only, etiological factor in the origin and growth of the myeloma. These cells are produced normally at first to remove calcified cartilage, and at a later stage in bone-development to remove bone (both trabecular and periosteal), whereby the marrow-cavity is increased in size; the ratio between thickness of diaphysis and diameter of marrow cavity is maintained within certain limits, which are an expression of greatest efficiency and strength of the bone, having regard also to economy of material. On functional grounds, therefore, it is legitimate to compare osteoclasts with 'foreign'-body giant cells: both are employed in removing material which is useless, or a hindrance to optimum development, and thus 'foreign' in the metabolism of the body. The conditions normally determining the formation and activity of the osteoclasts are not known. It may be that physical stresses in the bone are responsible, in the same way as they are responsible for the arrangement of the trabeculae at the end of a long bone, as well as for the protuberances of bones.

With regard to the cause of origin of a myeloma, the following are possible explanations: (1) A local injury to the periosteum (e.g., trauma caused by a blow) may result in hypertrophy of periosteal bone, and to preserve the ratio of thickness of bone shaft to diameter of marrow cavity an abnormal number of osteoclasts are produced. (2) There may be some change of metabolic origin resulting in the existing bone becoming altered in chemical composition and thereby calling into existence osteoclasts to remove it. (3) Some agency may cause a local change whereby the osteoclasts are abnormally increased in number: stimulation of osteoclasts to form, or, if formed, to multiply to excess, may result from the presence of a foreign body, parasite, or even wandering cells from some other part of the body. The following appear to us to be objections to (1) above. The infrequency of incidence of myeloid sarcoma as compared with the frequency of cases of bone injury seems to imply that some other attendant factor must be assumed if we are to attach much weight to this view; the injury would affect the subperiosteal lamellæ of bone more than the perimedullary; why, therefore, should the latter be removed at all? The chief objection to (2) is that a metabolic change would most likely be attended by a generalized pathological condition, and not one localized as is usually the case in myeloma. The few cases of multiple myeloma which occur can be satisfactorily explained by (3). On the whole, therefore, a local abnormal stimulation of osteoclast formation or of osteoclast division, whether auxetic, kinetic, or katabolic, seems to us the most probable explanation of the presence of large numbers of osteoclasts or giant cells at the periphery of a benign epulis. That it is not the presence of the spindle cells which is responsible for the giant cells is clear when we recall the distribution of the latter: i.e., few in the centre, where the spindle cells are most abundant, and numerous at the edge of the growth, where the spindle cells are comparatively scarce. Clinical evidence appears to favour (3), viz., that owing to some localized condition osteoclasts are formed in great numbers; in other words, a condition is created favouring the formation of osteoclasts.

Origin and Structure of Giant Cells and Osteoclasts.—Two kinds of giant cells in myeloma have been described—the true and the false. According to Poncet,⁶ the former are as large as three or four ordinary spindle cells, and contain five or six nuclei; the latter are rather larger and contain twelve to twenty nuclei; the 'false' giant cells are very numerous in the benign epulis. Borst drew a distinction between giant cells of medullary sarcoma and those of periosteal origin: he accepted a multiple origin for giant cells. Mallory⁷ distinguished true tumour giant cells (which may multiply by mitosis) from foreign-body giant cells (of bone and other sarcomas) represented in the epulis type of sarcoma; the former differ chiefly in size and number of nuclei from the latter, which are transformed wandering endothelial leucocytes not produced in the tumour. Virchow and Rindfleisch⁸ believed that, when bone-matrix is absorbed, the osteoclasts set free produced giant cells of the epulis type: thus they identify giant cells with osteoclasts. Robin⁹ and Nélaton⁵ took the same view. Wyss,¹⁰ Ziegler,¹⁰ and others trace the origin of giant cells in sarcoma to bone-forming cells; Ziegler suspected that osteoclasts might not all originate in the same way. Wegner,¹⁰ Malassez,¹¹ Ritter, and later observers have reached the conclusion that giant cells of the epulis type are

derived from modified endothelium and are therefore of angioblastic nature. Ewing³ considers that it is necessary to recognize in morphology and origin two types of giant cell in bone sarcoma. The type most common in benign epulis is chiefly of endothelial origin, and is a foreign-body giant cell which does not participate in the tumour process; the other type is derived from the tumour-cells, and occurs chiefly in malignant tumours of the *periosteum*. We consider that divergence of opinion upon the question as to whether there is more than one kind of giant cell in benign epulis is explained by the fragmentation process which these giant cells undergo; the gradations in character of the giant cells are similarly explained. The multinucleated cell shown in *Fig. 189* does not correspond with either of the types mentioned above.

Various other sources of origin of osteoclasts have been suggested: e.g., marrow mesenchyme, cells of the *periosteum*, connective-tissue cells carried by the blood to the medullary cavity may be cited to illustrate the uncertainty of our knowledge on this interesting problem.

Since these multinucleated cells are present wherever bone is to be removed, or, as in the case of the milk teeth, where the roots are to be absorbed, it is not unreasonable to postulate that they have an origin *ad hoc*, and that they are formed in a similar way to other foreign-body giant cells. Judging from our sections, we should unhesitatingly conclude with Kölliker and others that the osteoclasts are derived from the osteoblasts, for the following reasons: the great similarity in appearance, size, and staining reaction of osteoblast nuclei and the nuclei of an osteoclast; the fact that the two kinds of cells are always associated; that where an osteoclast is found against a bone, osteoblasts are absent; and the occurrence sometimes observable of osteoblasts apparently fusing together. In the myeloma we have described, the osteoclasts are very numerous at the periphery of the tumour nearest the bone; they are not so numerous where the tumour and marrow are continuous. We therefore favour the views of Kölliker that osteoclasts are derived from osteoblasts and ultimately break up into osteoblasts. Virchow, Rindfleisch, Robin, and Nélaton came to the same conclusion. Lambert's¹² work on the cultivation of the spleen of the chick in plasma indicates that spleen-pulp cells may fuse to give rise to giant cells. Thus this function is not confined to endothelial cells or to lymph-cells.

Formation of Spindle Cells.—The osteoclasts produced in great numbers do not, in our opinion, confine their attention solely to bone removal. The histological evidence appears to indicate that while some destroy the bone, others become phagocytes upon the elements of the marrow, viz., myelocytes, fat-cells, red and white blood-corpuscles, etc., and thus account for the absence of the normal constituents of marrow in the myeloma. We observed many giant cells which contained in their protoplasm other cells. Other giant cells presumably lose their osteoclastic function and undergo a process of dedifferentiation, i.e., they fragment into smaller and smaller cells until the uninucleate spindle-cell condition is arrived at, the original osteoclast nuclei becoming elongated and swollen in the process (*Figs. 187, 192, 193*). Similarly nuclei of cells undergoing dedifferentiation in tissue cultures become slightly swollen. The following is a summary of the evidence in favour of this view: The giant cells or osteoclasts in the myeloma are most numerous at the margin;

they vary in size, shape (many are elongated and have processes—*Fig. 186*), and number of nuclei (from twenty-four and upwards down to two); their cytoplasm exhibits gradation in its affinity for eosin—the giant cells with only a few nuclei have cytoplasm which resembles that of the spindle cells in not staining with eosin; the close resemblance between osteoclast and spindle-cell nuclei; the signs of fragmentation of many giant cells; and the difficulty of determining the boundary of some giant cells. To these we may add, in support of the view that the spindle cells are formed *in situ* and not brought by the blood, the fact that the blood-spaces have in them at first no spindle cells, but become invaded by them later; although some spindle cells are seen to be undergoing mitosis and possibly also direct division, the absence of any marked mitotic or amitotic division of



FIG. 192.—Giant cells undergoing fragmentation.

the spindle cells seems to exclude the possibility of any appreciable tumour growth in this way. Finally, the clinical evidence that growth of a myeloma is most rapid laterally, viz., in the neighbourhood of the bone where the osteoclasts are formed, rather than, as one would expect, along the line of least resistance, viz., the marrow cavity. The earliest stage of the disease has been traced by some writers to the walls of small 'cysts' or cavities which form in osteitis fibrosa cystica. Such an origin is not inconsistent with an osteoclastic fragmentation resulting in tumour formation.

Although fragmentation of cells in the manner described above is not known to occur in normal cell-division, yet when we recollect how these giant cells probably arise, viz., by a fusion of uninucleated cells, it is not unreasonable to predict that begin with a division of the multi-nucleate cells to produce cells with a single nucleus. Carleton¹³ defines



FIG. 193.—A group of giant cells arranged in such a way as to suggest that the larger cells divide up into smaller cells with fewer nuclei. At *a* some osteoblasts are visible. Their nuclei closely resemble the nuclei of the giant cells.

any dedifferentiation of the cells will nucleate cells to produce cells with

dedifferentiation as "the return of previously specialized elements to a simpler and more embryonic type"; it is the reverse of differentiation—"the process of specialization, functional and structural, of cells and tissues". Champy¹⁴ describes how, in tissue cultures of non-striated muscle-cells of the urinary bladder, the cells become swollen, lose their myofibrils, and cease to show any of the characteristics of the previously highly differentiated muscle-cells. Complete dedifferentiation to an indifferent condition occurs, and the resulting cells approximate in appearance to the undifferentiated cells of the early embryo.

Champy¹⁴ also was the first to notice that in tissue cultures some of the cells ingest phagocytically other elements present. Thus in testis cultures the Sertoli cells first agglutinate and then ingest the spermatocytes. We have mentioned that the giant cells ingest other cells; this may be explained

as the normal function of these cells, indeed their *raison d'être*. It is perhaps not without significance that whereas many observers have noted the phagocytic properties of the giant cells in myelomata, histologists are far from unanimous with regard to whether osteoclasts ingest bone or destroy it by producing an enzyme. If this difference in function exists between osteoclasts and giant cells, it may be cited against our view that the osteoclasts are the giant cells in a benign epulis. On the other hand, the phagocytic function assumed by the osteoclasts is characteristic of some dedifferentiating cells.

Yet another question of interest is the influence of environment on tumour-cell outline. It has been mentioned above that, where an invasion of a blood-space occurs in

the myeloma, the cells in the blood are usually fusiform with elongated nuclei, though others appear to be small and round. At the periphery of the space the invading cells have more oval nuclei, like the great majority of the tumour-cells. This observation is in accordance with the findings of Uhlenhuth¹⁵ for tissue growth in culture—the growth in a semi-hard medium was effected by fusiform cells migrating individually into the surrounding plasma.

Since these observations were made, we have read Carleton's admirable critical summary of tissue culture,¹³ and we cannot refrain from noting the parallelism which in our opinion exists between the behaviour of the cells producing the myeloma, and certain established phenomena in cultures of

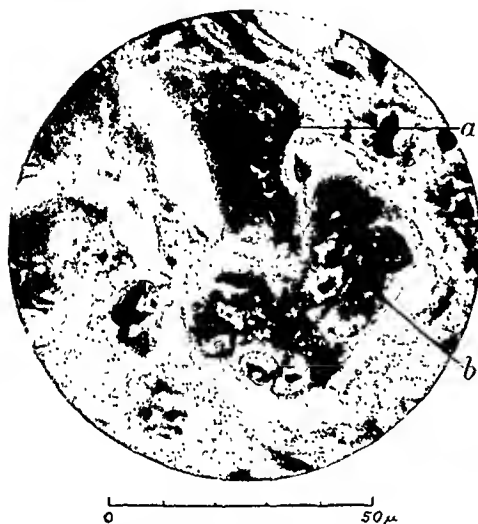


FIG. 194.—The giant cells referred to in Fig. 193 under higher magnification. One smaller cell at *a* is just about to separate from the main mass *b*; the separation is not yet complete.

tissue, viz., dedifferentiation and phagocytosis. In dealing with the application of tissue culture, Carleton asks this question, "Are the factors which produce dedifferentiation on the part of specialized tissues *in vitro* the same as those which produce the formation of malignant tumours *in vivo*?" The evidence which we have given bearing on the formation of the benign epulis indicates that the factors may be the same. Although we do not contend that the method of formation of a giant-cell myeloma is a prototype whereby the formation of malignant growths may be explained, it is sufficient at this stage to observe that many tumours apparently benign may later become malignant.

SUMMARY AND CONCLUSION.

1. The giant cells in a benign epulis or giant-cell myeloma appear to be derived from osteoclasts.
2. The removal of the marrow by giant-cell phagocytosis and the formation of the tumour cells by fragmentation of giant cells may be likened to the dedifferentiation changes which occur in certain cells in tissue cultures.
3. A few giant cells were seen in the myeloma with nuclei exhibiting an uncommon type of karyokinesis which is associated with some protozoa.
4. Some few other multinucleate cells with small nuclei and strongly eosinophil cytoplasm were seen : observations upon these are being continued.

We are indebted to Professor R. C. McLean for kindly permitting us to use the photomicrographic apparatus in his department ; also to Miss M. White for the drawings in *Fig. 186*.

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PLEXIFORM NEUROFIBROMA OF THE SOLAR PLEXUS.

By HERBERT A. BRUCE, TORONTO.

ONE of the most valuable contributions to the subject of tumours of nerves was that made by Mr. Alexis Thomson,¹ Professor of Surgery in the University of Edinburgh, in a monograph on neuroma and neurofibromatosis, published in 1900.

The term 'neuroma' was introduced by Odier, of Geneva, in 1803, to designate "tumours formed by diseased enlargements of the nerves". William Wood,² of Edinburgh, discussing the origin of neuromata in a paper in the transactions of the Medico-Chirurgical Society of Edinburgh in 1829, believed them to originate from the connective-tissue sheaths of the nerve, and not from the nerve tissue itself. He remarked upon the inefficacy of medicines, and recommended removal of the tumour by operation. Amongst others he quoted a case from the *Encyclopédie Méthodique de Chirurgie* (Paris, 1792) in which amputation was performed for what was undoubtedly a plexiform neurofibroma of the median nerve of the forearm. Smith, of Dublin, in his classical work on neuromata in 1849, considered that the mere anatomical connection of a tumour with a nerve was sufficient to regard it as a neuroma, whatever its structure might be. However, Virehow, in his lectures published in 1863, placed the pathology of neuromata on a new basis, by classifying them on a structural instead of a clinical basis, and dividing them into the true and the false—the former composed mainly of new nerve tissue, the latter (pseudo-neuroma) of connective tissue derived from the sheaths of the nerve. True neuromata are very rare, but several authentic cases have been recorded.

Attention is called to the present case of plexiform neurofibroma of the solar plexus, not only because of its inherent interest and rarity, but because it has to be taken into consideration in a differential diagnosis of abdominal tumours: however, as I am only able to find one other case of plexiform neurofibroma affecting the solar plexus in the literature, one given by Bruns,³ it will not be necessary to work out elaborate methods for its detection.

J. K., age 35, referred to me by Dr. R. J. MacMillan, gave a history of having been injured in a fall at the age of 18. He had never had any serious illness until an attack of influenza four years ago which confined him to bed for three months. Since that time he has had constant pain in his back in the right lumbar region, accompanied by tenderness on deep pressure, usually relieved by a belladonna plaster. At irregular intervals, increasing of late, this pain in his back would be so severe as to confine him to bed for several days, and was generally regarded as lumbago. When free from these attacks he had a good appetite, appeared to be in good health, although always very thin, and carried on his usual work. The tumour became palpable about three months before I saw him. Two months ago he suffered from lenteric

diarrhœa, which cleared up on milk diet. For the last few weeks he had not been able to retain any solid food, and had even vomited most of the fluids given. When he entered the hospital his urine was found to contain diastase. Examination of the abdomen disclosed a tumour about the size of a grape-fruit in the mid-epigastrie region, only very slightly movable from side to side. It felt solid, and had a tympanitic note over it. The abdomen otherwise was very thin, tense, and emaciated. There was no pigmentation of the skin, and no nodules were seen in any other part of the body.

An X-ray examination was made by Dr. H. M. Tovell, who reported as follows :—

There is no definite radiographic evidence of a pathological condition in the stomach or bowel which would indicate ulceration or malignancy. There is evidence that a mass external and posterior to the stomach is pressing upon the lesser curvature and also upon the transverse colon. From the position of the mass one would be suspicious of the pancreas; yet there is no evidence of displacement of the duodenum, which assumes the usual relation to the stomach, which one would think would not be the case if a pancreatic tumour were present.

However, a diagnosis of 'tumour of the pancreas' (probably a cyst) was made, and it was thought that the injury referred to above might have been a causative factor. Under anæsthesia the tumour, which was very hard and nodular, could be moved freely from side to side, and to a less extent from above downwards. On making the incision, the transversalis fascia was found tightly stretched over the tumour, and when it and the peritoneum were divided, the tumour popped out as if under great pressure. It was then seen to press forward the gastrohepatic omentum and the stomach, which was tightly stretched over it. The pylorus, which was lying in the middle line, was widely dilated, as were also the first and second portions of the duodenum. The glands along the greater and lesser curvatures were not involved. The tumour mass was about the size of a grape-fruit, distinctly nodular, and appeared to be connected with the pancreas. Thinking it malignant and inoperable, after removing a couple of nodules for microscopical examination, the abdomen was closed, but with considerable difficulty.

We were surprised at receiving a report from the pathologist that the section was a myoma. In view of these findings, and the fact that the patient was unable to retain any nourishment owing to the mechanical effect of the tumour in shutting off the outlet of the stomach making a fatal result inevitable in a very short time, we decided to try to remove the tumour. The former incision was re-opened twelve days later, and a thorough examination of the tumour, both through the gastrohepatic omentum and the transverse mesocolon, revealed it lying behind the pancreas, which was not involved. A good deal of difficulty was met with in dissecting out the growth, as a number of very large blood-vessels coursed through it. The mass looked a little like a thick tapioca pudding, with a fine mesh of fibrous tissue stroma between the little nodules. The patient recovered nicely from the immediate effects of the operation, and the same evening his pulse was good and his condition seemed satisfactory. However, he died suddenly the next morning, probably from pulmonary embolism.

I am indebted to Dr. G. W. Longheed, Pathologist to the Wellesley

Hospital, for the careful dissection and examination of the tumour, and the following report:—

Gross Specimen.—Consists of a large tumour mass which is growing in an irregular fashion. There are a large number of grape-like masses projecting from the inner surface of this tumour. They are firm in consistency, whitish in colour,

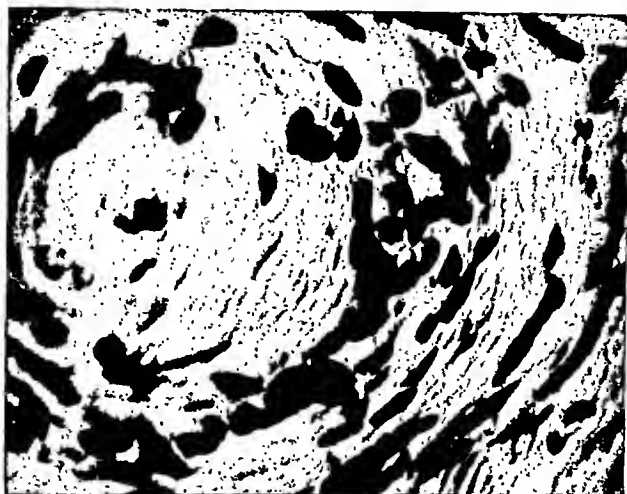


FIG. 195.—Microphotograph showing whorl formation of non-medullated nerve fibres. High dry power $\times 10$ eye-piece ($\frac{1}{8}$ scale).

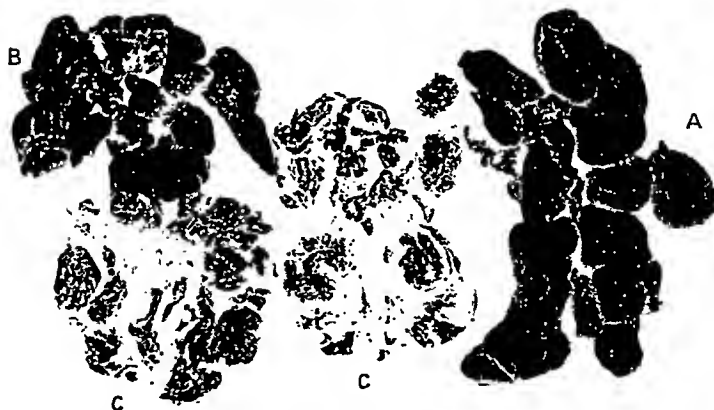


FIG. 196.—A, Dissected portion of tumour showing plexiform arrangement of neuro-fibromata. B, Cross-section of dissected portion. C, Undissected portion of tumour. Gross tumour measures $5 \times 3 \times 2\frac{1}{2}$ in. The illustration represents about one-tenth of the tumour, and the nodules are natural size.

and on section have a slight tinge of green. The remainder of the tumour is red in colour, and appears to be covered with a firm thin sheet of fibrous tissue. Beneath this are more of these grape-like masses.

Microscopic Findings.—Slides of some of these nodules show them to be made up of a loose areolar connective tissue with numerous nerve bundles running through

it. There is a fair amount of collagen material present, and in places the tissue is rather œdematous in character. There is no evidence of ganglion nerve-cells present. The majority of the tumour is made up of non-medullated nerve fibres intimately surrounded by fibrous tissue. (*Figs. 195-198.*)

Diagnosis.—Neurofibroma (plexiform).



FIG. 197.—Section of one of the nodules showing nerve bundle present, with surrounding loose areolar connective tissue. Low power $\times 5$ eye-piece ($\frac{2}{3}$ scale).



FIG. 198.—Demonstrating whorls of non-medullated nerve fibres, surrounded at top of picture by well-formed fibrous tissue. Low power $\times 10$ eye-piece ($\frac{2}{3}$ scale).

The plexiform is the most interesting type of neurofibromatosis. It is a fibromatosis confined to one or more contiguous nerves or a plexus of nerves. The lesion is the same as the more generalized form of neurofibromatosis,

and the two conditions may be met with in the same individual. Although rare, Bruns collected 42 cases, and Thomson 18, which with 2 of his own make a total of 62. It is stated that the tumour may undergo degeneration and may even disappear (Baumgarten), but Thomson agrees with Goldmann that such changes are altogether exceptional. A peculiarity of the plexiform type is the tendency, although involving a purely sensory nerve, to penetrate the adjacent muscles. There may be an overgrowth of subcutaneous tissue and skin in relation to a plexiform tumour which is best described by the term 'elephantiasis', where the skin frequently shows excess of the normal pigmentation. By far the most frequent situation of plexiform neurofibromatosis is the subcutaneous tissue of the head and neck—in the distribution of the trigeminal and superficial cervical nerves—although it may be met with anywhere throughout the sympathetic and peripheral cerebrospinal systems.

The following table is given by Bruns, with additions collected by Thomson :—

SITES OF PLEXIFORM NEUROFIBROMA.

Temple, forehead, and upper eyelid	..	..	18 cases
Posterior part of neck and behind auricle	..	..	14 "
Nose and cheek	..	..	4 "
Region of lower jaw, and anterior half of neck	..	..	5 "
Breast and back	..	..	8 "
Extremities	..	..	9 "

The nerves of the extremities include the median, musculospiral, radial, and small sciatic. Goldmann and Pomorski have each recorded a case in which the intercostal nerves were affected, the tumour projecting into the pleural cavity. Bocasso observed a tumour below the jaw, passing along the hypoglossal nerve into the substance of the tongue. Bruns drew attention to the fact that the most common seats of the plexiform neurofibroma are also the most common situations of elephantiasis neuromatosa or pachydermatocele, with which it is frequently associated.

Plexiform tumours are found coexisting with a generalized fibromatosis and with multiple skin-fibromata (molluscum) in about 50 per cent of cases.

Plexiform neurofibroma resembles the elephantiasis with which it is commonly associated, inasmuch as it may be present at birth or develop in early infancy. As to the influence of heredity, a study of the cases demonstrates the fact that neurofibromatosis is sometimes inherited and sometimes met with as a family disease, and gives support to the view that the chief etiological factor in the disease is one which dates from intra-uterine life. Other defects of developmental origin are frequently seen associated with this disease. So far as our present knowledge goes, Bruns, Goldmann, Thomson, and others consider that the condition is a form of giantism or elephantiasis of the connective-tissue elements of the peripheral nervous system.

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DUODENECTOMY.

BY CHARLES A. PANNETT, LONDON.

THE history of the treatment of chronic gastric ulcers has passed through several stages in its evolution. The greatest advance was made when it came to be recognized that certain penetrating callous ulcers cannot be induced to heal by any known non-operative measures. Surgical intervention was thus proved to be necessary, and various suggestions were put forward as to what the appropriate treatment should be. Accumulative experience gained in clinics the world over has established the pre-eminent position that direct methods must hold over indirect procedures, of which the most commonly practised is gastrojejunostomy. The problem of the treatment of chronic duodenal ulcers is passing through the same phases of study. A very high percentage of successes after gastrojejunostomy has been obtained by Moynihan¹; but abroad, particularly, a certain dissatisfaction with the results of simple gastrojejunostomy was being felt and expressed in the period immediately preceding the Great War. The essential sameness of the pathology of chronic gastric and duodenal ulcers suggests like remedies, and renders it desirable that the possibilities and results of direct measures should be explored in the case of the duodenum, as in the stomach. In this country very little work has been done in this direction, owing to the good results which have been obtained by gastrojejunostomy; but the results in foreign clinics do not approach them in the degree of success obtained. Thus Bier claims only 66 per cent of cures with simple gastrojejunostomy, but 83 per cent if it is combined with some stenosing operation upon the pylorus. Von Haberer puts his successes after simple gastrojejunostomy as low as 37 per cent, though it must be remembered that he reserves this operation for those cases where excision is impracticable. A number of observers have reported cases where gastrojejunostomy failed to bring about healing in duodenal ulcers, as proved by subsequent operation or autopsy. Haberer saw severe hæmorrhage eight years after gastrojejunostomy combined with pyloric exclusion, whilst O. Maier² reports a similar case, where two years later not only were the two original ulcers of the duodenum unhealed, but a new ulcer at the anastomotic margin had appeared.

Examples of failure to cure the symptoms of pain and hæmorrhage after simple gastrojejunostomy for duodenal ulcer could be added to from personal experience, but it must be borne in mind that it will always be possible to collect failures from any method of treatment which falls short of absolute perfection. The crux of the question is obviously the extent to which such failures occur. If our indirect methods are to be displaced by direct ones, it must be proved that the latter give a higher percentage of permanent cures than are reported by the authoritative operators in this country. Opinion seems to have crystallized abroad that radical measures, when they are practicable, are the methods of choice. The aim of this communication is

not to extol the excision of duodenal ulcers as being the best treatment at our disposal, but to popularize the operation of duodenectomy, so that the data may be collected on which we may confidently base our judgement in favour of one or other method.

The history of the operation goes back only a few years. At the German Surgical Congress held at Berlin in 1913, Richter³ stood alone in recommending excision for duodenal ulcers. The operation had been followed by a very high mortality in most surgeons' hands, so that the radical removal of duodenal ulcers which had penetrated into the pancreas was held to be almost always impossible on anatomical grounds. Von Hofmeister,⁴ who was able to report three successful duodenectomies, had injured the common bile and pancreatic ducts in one case, the patient recovering only after a protracted illness and several subsequent operations. He comments upon the difficulty and danger of the method. About 1916, however, attention was again directed to the question, and P. Clairmont⁵ gave the first description of a technique for duodenectomy. Finsterer, and particularly Haberer, explored the possibilities of the procedure, and though both Clairmont and Haberer were cautious in their advocacy of the operation and insisted on the careful selection of cases necessary, yet gradually the field of possibility was enlarged, so that, by 1921, E. Nowak⁶ was able to report 44 resections, the last 41 of which formed a consecutive series. This means that excision is possible in nearly every case. The degree to which the operation has been exploited abroad is to be gathered from the following statistics: H. Finsterer⁷ reports 236 resections with a 3.4 per cent mortality (2 per cent in the last 198 cases), and H. von Haberer⁸ 169 resections. Both these authors insist upon the good results obtained, Haberer affirming that they are beyond comparison with those following gastrojejunostomy alone or combined with pyloric exclusion. The few examples cited here are ludicrously small in comparison, and to draw any sweeping deductions from them would be absurd. Yet they illustrate the difficulties of the operation to which all authors refer, whilst the account of the technique employed may prove of assistance to other surgeons interested in this subject.

Two pathological facts assume great prominence when duodenectomy is under consideration. They are the tendency to widespread fibrosis in the neighbourhood of the ulcer, and the frequency with which two ulcers are present. This last occurred five times in my small series.* The first phenomenon is so important because of the nearness of the common bile and pancreatic ducts and their liability to injury unless great care be taken, for they early become surrounded by fibrous tissue which has invaded the gastrohepatic ligament and pancreas. *Fig. 199* shows the anatomy of the structures in the neighbourhood of the duodenum. In the case of the stomach it is easy to control the blood-supply before resecting, by ligature of the main vascular trunks. But this is not possible in the case of the duodenum, because the pancreaticoduodenal artery conveys blood, not only to the duodenum itself, but to the head of the pancreas. It is therefore necessary to ligate the

* Subsequent experience has shown that the incidence of two ulcers is really greater than here suggested, and that sometimes the posterior ulcer remains unsuspected even after an examination, and is revealed only during the course of the resection operation.

numerous small branches which come off from the vessel and enter the pancreatic wall of the duodenum. This is a tedious and time-consuming procedure, but it must be done with meticulous care, since the obscuration of the area of operation by blood may lead to serious consequences from loss of the power of orientation. There are indeed two main guiding principles in duodenal resection: to keep the dissection close to the wall of the viscus, so that damage to the bile or pancreatic ducts may be avoided; to control the blood-supply by tying the small terminal branches separately.

It is necessary to gain free access to the site of operation. This can be done by a right paramedian rectus-sheath incision with retraction of the muscle. I have not yet found it necessary to supplement this by a cross-section of the rectus as recommended by Haberer and by Nowak. When the abdomen is opened, an impression of impracticability of resection is often first obtained, because periduodenitis is apt to hide the duodenum from view,

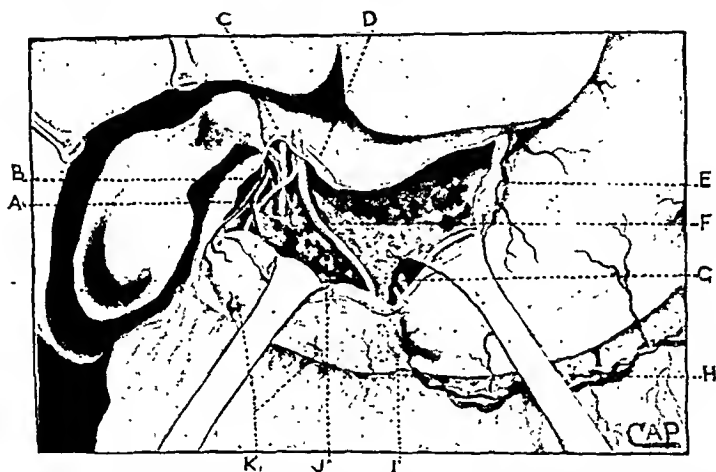


FIG. 199.—The lesser omentum has been divided: the first part and genu of the duodenum have been dissected away from the posterior wall of the abdomen, revealing the relations of it to the pancreas, bile-ducts, and neighbouring vessels. A, Pancreatico-duodenal artery; B, Pancreatico-duodenal vein, joining portal vein; C, Common bile-duct; D, Pyloric artery; E, Coronary vessels; F, Right gastro-epiploic artery; G, Superior mesenteric vein; H, Right gastro-epiploic vessels; I, Pylorus; J, Pancreas; K, First and second parts of duodenum, retracted downwards.

or to shorten it and drag it back to the posterior abdominal wall, to a pronounced degree. Clairmont pointed out how division of these adhesions frees the duodenum in a remarkable way. A surprising elongation of the viscus occurs. When this has been done, it must be decided whether it is possible to proceed without serious risk to the patient. As experience increases, so does the range of operability. I have met with two cases since I have begun resecting duodenal ulcers where I preferred to do a gastro-jejunosomy, because very extensive fibrosis obscured anatomical relations too much; but, as mentioned above, Nowak was able to perform an uninterrupted series of 41 resections. Nevertheless there are contra-indications. If the operator feels that he cannot keep clear of the common bile-duct, if he cannot define it in the gastrohepatic omentum, or if the ulcer extends so far

down that it seems probable that the common-duct papilla has been reached, then he must abandon resection. Nowak affirms that he has never met a duodenal ulcer which reached the biliary papilla; but Finsterer, with his huge experience, recognizes that some cases are not suitable for radical measures. This is only to be expected, for, in the case of the analogous gastric lesion, examples are certainly met now and then when the only possible method of treatment is the indirect one of jejunostomy, as Moynihan has pointed out. If the bile-duct in the margin of the gastrohepatic omentum can be defined, and if the finger and thumb can, by encircling the second part of the duodenum, feel only normal tissue in their grip below the callous mass in the pancreas, and it is reasonably certain that this point is above the opening of the common bile and pancreatic ducts, then the operation can be proceeded with. I think it can be accepted as true that very few ulcers reach down as far as the opening of the ducts in the second part of the duodenum.

THE TECHNIQUE OF RESECTION.

The first step then is to cut through the attachment of the greater omentum just below the pylorus, ligating any vessels in the way. It is usually quite easy to make this separation between the stomach and the right gastro-epiploic vessels, which are then not interfered with. Quite often,

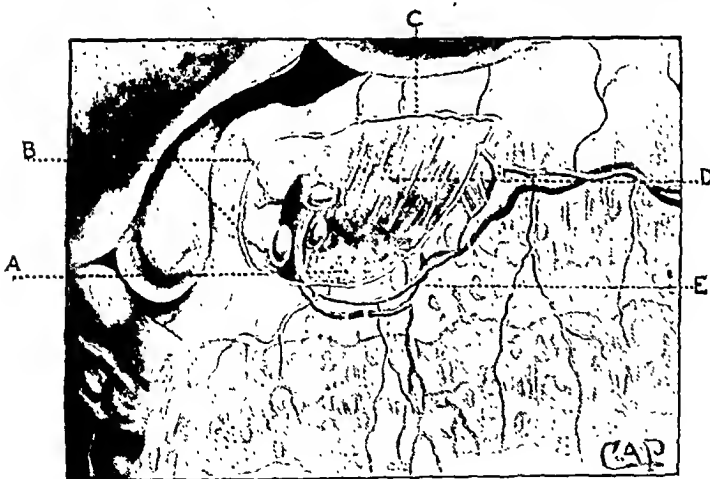


FIG. 200.—The attachment of the peritoneum to the greater curvature of the stomach and duodenum has been divided, opening up a considerable extra-peritoneal space present when the lesser sac does not extend as far to the right as usual. A, Pancreas; B, Branches of pancreaticoduodenal artery; C, Attachment of the great omentum; D, Reflection of peritoneum which forms the right extremity of the lesser sac; E, Right gastro-epiploic vessels.

after this procedure, the lesser sac is not opened as is expected. It is puzzling to find another avascular layer of peritoneum spread out between the stomach and posterior abdominal wall (*see Fig. 200*). This is really the layer forming the right extremity of the lesser sac, perhaps drawn somewhat further to the left by traction on the stomach. If this is penetrated, the lesser sac is entered, and it is then quite simple to make a hole in the lesser omentum just proximal to the pylorus, and pass a strand of gauze round the pyloric segment of the stomach to act as a tractor, as in *Fig. 201*. The freeing of the border of the duodenum which is a continuation of the greater curvature of the stomach is now carried out, every small vessel being ligated before

division. If a director can be passed between the pancreas and duodenal wall below the ulcer, as depicted in *Fig. 201*, it is an immense help in subsequent steps. A ribbon of gauze should replace the director. Separation in the natural plane between the duodenum and pancreas takes place easily where there is no fibrosis. Attention is now directed to the border which is a continuation of the lesser curvature of the stomach. Here the pyloric artery should be defined, and divided between ligatures, and the attachment of the gastrohepatic ligament severed from the stomach. This separation is often one of the most difficult parts of the operation, as the ligament is apt

to be transformed into a callous mass. It must always be remembered that the common bile-duct is very close to the bend of the duodenum at this point. It should be defined if possible. I have not been able to do this clearly in every case, but the rule to be followed is simple: Keep close to the duodenal wall and avoid mass clamping or ligations. It cannot be emphasized too strongly that caution is essential at this stage. When the viscus is sufficiently freed, access to the posterior aspect of the duodenum can be better obtained by cutting

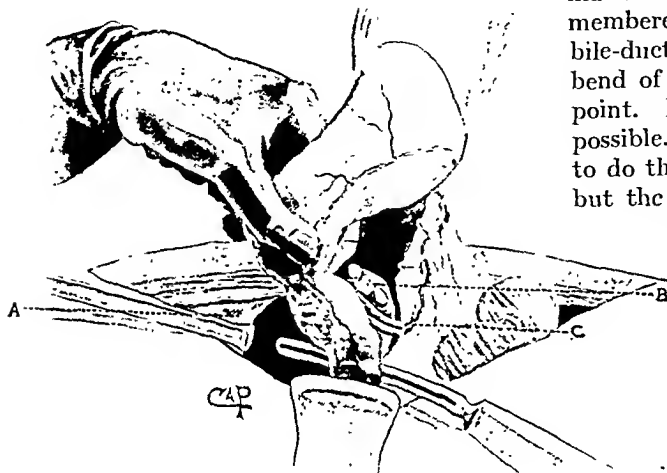


FIG. 201.—The omentum has been separated along its greater and lesser curvatures. A director has been passed between the pancreas and the duodenum distal to the ulcer. A, Liver; B, Pancreas; C, Right gastro-epiploic vessels.

across the stomach just proximal to the pylorus between clamps. The duodenum can thus be turned over to the right, exposing the pancreas behind and to its medial side (*see Fig. 202*). The tedious business of separating the viscus from the pancreas is now more easily performed. Each branch coming off from the pancreatico-duodenal vessels must separately be doubly ligated before division. A bloodless field is almost an essential. When there is much fibrosis of the head of the pancreas, and the proper plane of separation cannot be accurately determined, it is proper to cut round the margin of the ulcer, leaving the floor in the pancreatic tissue untouched. Escaping duodenal contents should be mopped up. Their dissemination is prevented by the preliminary packing round the area of operation, which is carried out as in any abdominal procedure. Having opened the lumen of the duodenum, it is sometimes difficult to find again the right plane of dissection below the fibrosed area. The search, however, is very greatly simplified if a strand of gauze has been thrown round the distal part of the duodenum as described above. When healthy gut has been reached, it is grasped in the blades of a

narrow clamp (a long narrow Kocher forceps will do) and cut across, the clamp remaining on the distal segment.

The restoration of continuity of the alimentary canal is brought about usually by axial anastomosis, sometimes by Moynihan's no-loop method of end-to-side gastrojejunostomy. A sufficient amount of stomach having been

removed, the axial union is proceeded with as follows. A gastric clamp controls the escape of stomach contents. A duodenal clamp is not used for the same purpose, as it gets too much in the way, and the escape of duodenal contents is not usually too great to be dealt with. The clamp closing the duodenal end is rotated to expose the posterior aspect of the gut, and applied to the stomach as in *Fig. 203*.

The posterior seromuscular suture is inserted. The completion of the anastomosis follows ordinary practice. The clamp on the duodenal end is simply removed. The tissue damaged in its grasp is very narrow,

does not seem to influence healing, and is not cut away. Owing to the previous compression of the edge, there is very little hæmorrhage from the duodenal stump. Nearly always a part of the lumen of the stomach has to

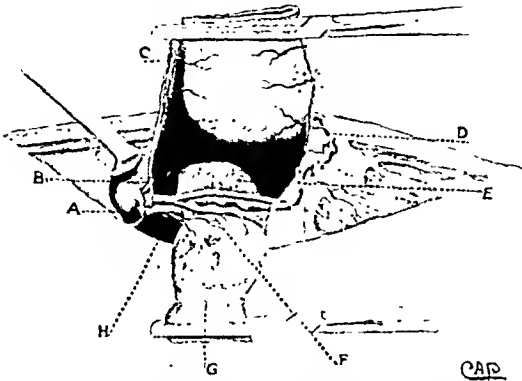


FIG. 202.—The stomach has been cut across just proximal to the pylorus. The pancreatic aspect of the duodenum is exposed, showing branches running into it from the pancreatico-duodenal vessels. Notice the proximity of the common bile-duet. A, Gall-bladder; B, C, Pyloric artery; D, Right gastro-epiploic vessels; E, Pancreas; F, Pancreatico-duodenal artery; G, Pylorus; H, Gastro-duodenal artery, common bile-duet, pancreatico-duodenal vein.

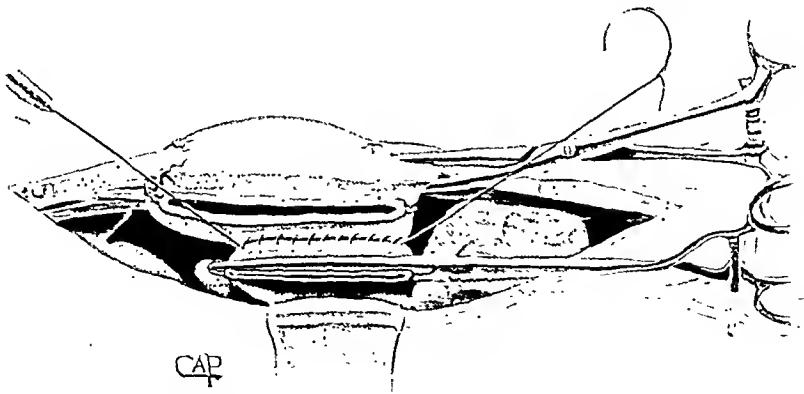


FIG. 203.—First stage in the anastomosis of the stomach to the duodenum.

be sewn up separately to adapt it to the smaller lumen of the intestine, as shown in *Fig. 204*. There has been no trouble at the much-feared dangerous angle. The insertion of the posterior seromuscular suture is sometimes troublesome, but it is important that the suture of the posterior wall of the

duodenum should be carefully and accurately done. Union occurs easily and firmly, as the non-peritoneal surface of the duodenum adheres quickly to the peritoneal-covered gastric surface. In *Case 2*, when the ulcer area had been separated and removed, so little duodenum above the papilla remained for suture that only one layer behind was possible. The convalescence was as smooth and uninterrupted by incident as in any other case. It is quite possible that a single Connell's suture, at least for the posterior aspect, will prove the method of choice.*

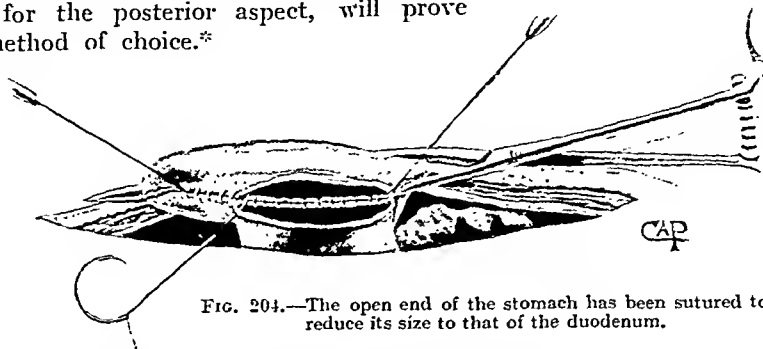


FIG. 204.—The open end of the stomach has been sutured to reduce its size to that of the duodenum.

THE DISADVANTAGES AND DANGERS OF THE OPERATION.

One disadvantage is the length and tediousness of the operation. I have not been able to perform a partial duodenectomy under an hour and a half, and the difficult cases have taken two hours. A simple pylorectomy may be quickly done; but when any considerable length of duodenum is removed, the necessary ligation of so many small vessels consumes much time, whilst when there is a great deal of fibrosis in the neighbourhood every step must be carried out with caution and deliberation. The duration of the operation has had very little noticeable effect upon the patients. The whole procedure is performed with a minimum exposure of the viscera. Usually the small intestine is not seen, and scarcely a glimpse is had of the transverse colon. These viscera remain throughout undisturbed within the abdomen. The anaesthesia during most of the time need be only very light. The statistics quoted above demonstrate how low the immediate mortality may be. Still the operation calls for an unusually sustained effort of concentration and care on the part of the surgeon, and this may be accounted a drawback.

The dangers of the operation are not small. The major one is that of injury to the bile or pancreatic ducts. Injury of the pancreatic ducts is more serious than that of the bile-duct. This subject has been studied by P. Clairmont.⁹ He points out that of 7 deaths following duodenectomy, 5 were due to injury of the pancreatic duct, whilst another was due to injury of the common bile-duct. Pancreatic injuries are very fatal; but sometimes recovery occurs after a stormy convalescence and, usually, secondary interventions. The injury is followed by a rapid pulse, high temperature, signs of local peritonitis, abscess formation, fat necrosis, and the appearance of a

*This method has been employed twice since the above was written, with satisfactory results.

pancreatic fistula should the patient survive the first few days. In cases that recover are seen a striking pallor, arrest of convalescence, anorexia, great wasting, and tachycardia. Special tests show pancreatic insufficiency. In one of my patients (*Case 5*) the common duct was cut right across as it lay in the callous mass forming the head of the pancreas. As a papilla was seen in the resected portion of duodenum, it is supposed that the pancreatic duct was severed at the same time, though it was not demonstrable in the area of operation. The common bile-duct is very evident in an accident of this kind, because it gives vent to green bile; but the pancreatic fluid is colourless, whilst the duct is smaller in calibre than that which conveys bile. In this particular case, by turning in the margin of the duodenum and suturing it to the pancreas, the raw surface of this latter viscus, which had been injured and which contained the ducts, was implanted into the open end of the duodenum. A fortunately happy result followed this procedure, the patient getting quite well with comparatively little disturbance of his convalescence.

In connection with this subject certain anatomical facts must be remembered. There is very frequently an accessory pancreatic duct (duct of Santorini) which enters the duodenum nearer to the pylorus than the main duct. In 8 per cent of cases, according to Clairmont, this is of such a size that it forms the main channel for the delivery of the pancreatic juice. Normally the duct of Santorini opens about 4 cm. from the pylorus, whilst the papilla of Vater is approximately 6 cm. from the same point. Often the two openings are much closer together. In 100 cases of duodenal resection reported by the same observer, a pancreatic duct was met with fifteen times. Only by very careful dissection can injury be avoided. If a duct is not larger in calibre than that of a steel knitting-needle, it can usually be ligated and divided, as it is the accessory duct: if larger than this, it must be preserved. Injury of the pancreatic tissue alone, without division of its ducts, may cause complications. Such damage can be prevented by always leaving the floor of the ulcer on the pancreas intact, making no attempt to remove it, and, by careful hæmostasis, avoiding the necessity for passing a number of sutures through the pancreatic substance to control hæmorrhage. Ligation of the pancreaticoduodenal artery at a single point can be done apparently without any harm resulting. In one of my cases I had to ligate the trunk of the corresponding vein. There were no ill effects.

THE PLACE THAT DUODENECTOMY SHOULD ASSUME IN THE TREATMENT OF DUODENAL ULCER.

Should resection of the duodenum displace gastrojejunostomy as the method of choice? The answer to this will depend partly upon the end-results obtained, and partly upon the as yet unproved point as to whether the increased advantage gained, should such be proved, is commensurate with the added risk of the operation. The operative mortality has been brought down to a figure not very much greater than that of simple gastrojejunostomy (v. Haberer 3.5 per cent in 169 cases, H. Finsterer 2 per cent in last 198 cases). We still await more reports of late results. Haberer regards them as very much more satisfactory than those following any indirect

method. It is essential that experience of the operation in this country should be accumulated to come to a decision on this question. Finsterer¹⁰ regards resection as the method of choice. He claims, after five years or longer, 93.6 per cent absolute cures in 63 cases when the duodenum and one-half of the stomach were removed. However, he stresses the technical difficulties of it, and indeed has published a series of cases where, in preference to attempting resection, he performed exclusion of the pylorus and gastro-jejunosomy, with removal of the whole of the pyloric section of the stomach,¹¹ obtaining thereby 84.8 per cent two-year cures in 33 cases.

One other problem in connection with the operation remains to be decided, namely, the amount of stomach which it is advisable to remove at the same time as the affected duodenal segment. Some surgeons divide the stomach across, just proximal to the pylorus, whilst others, who follow the teaching of Finsterer, remove two-thirds or four-fifths of the stomach, by which means they permanently reduce the digestive power of its secretion and claim to remove the tendency to ulcer formation.

CASES.

Case 1.—D. H., male, age 40. Indigestion in attacks, with free intervals, for nineteen years. Pain three to four hours after food, relieved by the next meal. Vomiting occurs. Attacks getting more frequent and longer in duration.

BARIUM MEAL.—Deformity persistent in first part of duodenum: some delay in emptying time.

OPERATION.—Aug. 28, 1923. Paramedian laparotomy with retraction of the rectus muscle. An ulcer present on upper wall of first part of duodenum, extending round to the posterior wall. A good deal of fibrosis present, extending into pancreas. Greater curvature of stomach dragged over and adherent to second part of duodenum. Preparation of duodenum and excision of the affected portion with axial anastomosis in ordinary way.

Convalescence smooth.

Case 2.—F. W., male, age 33. Indigestion for many years. Pain has no relation to food, but is worse if intervals between meals are longer than usual. No vomiting. Two weeks ago awoke with severe abdominal pain, which was followed by copious melaena and by fainting.

BARIUM MEAL.—Shows a persistent irregularity of first part of duodenum, and a residue in stomach five and a half hours after the meal.

OPERATION.—Oct. 18, 1923. Paramedian laparotomy with retraction of the rectus muscle. A puckered ulcer on anterior wall of first part of duodenum, and a large one behind in second part, penetrating the pancreas. Preparation of duodenum according to usual technique. Stomach cut across just proximal to pyloric sphincter. In separating the second part of duodenum, the lumen had to be penetrated by cutting round the margin of the ulcer on the pancreas. When normal duodenal wall was reached again, it was found that there was only sufficient to put in one row of sutures. Axial anastomosis between duodenum and stomach was therefore performed, using one layer of penetrating sutures behind and the usual two layers of sutures in front.

Convalescence proceeded without incident.

Case 3.—E. C., male, age 42. Twelve years' history of indigestion with remissions. Complaints much worse for last six months. Pain one to two hours after food. Vomiting occurs and relieves the pain. Exploration eight years ago in another hospital, but no lesion of stomach or duodenum found.

BARIUM MEAL.—Deformity of first part of duodenum. Small shadow persists here after stomach is empty.

OPERATION.—Oct. 31, 1923. Median laparotomy through old scar. A large mass present in posterior wall of first part of duodenum, extending down to second part. A large ulcer crater could be felt by invaginating the anterior duodenal wall with the finger. Much fibrosis of head of pancreas. Mesocolon dragged up in a fold and adherent to the mass. Much thickening of the gastrohepatic ligament. Separation of lesser and greater omenta from prepyloric region of stomach. Division of stomach $1\frac{1}{2}$ in. proximal to pylorus. The duodenum was then separated from the fibrotic pancreas and gastrohepatic ligament, the floor of the ulcer being left attached to the pancreas, which necessitated incising into the lumen of the duodenum around the margin of the ulcer. Suture of duodenal stump. Anastomosis of open end of stomach to the first part of jejunum by Moynihan's technique.

Convalescence smooth.

Case 4.—H. P., male, age 36. Indigestion for eighteen months in attacks, with free intervals. Hunger pains.

BARIUM MEAL.—Stomach hypertonic, but there is delay in emptying time. Shadow of bulb indistinct. Pylorus more to right than usual.

OPERATION.—Nov. 29, 1923. Paramedian laparotomy with retraction of rectus muscle. An ulcer present on anterior wall of first part of duodenum. Mobilization of duodenum by usual technique, followed by excision of affected part together with the pylorus, and end-to-end anastomosis. This operation was performed without difficulty, as infiltration of the pancreas and gastrohepatic ligament was absent.

Case 5.—F. G., male, age 55. Nine years' history of pain and vomiting after food (four to five hours). The indigestion has been continuous, with no completely free intervals.

BARIUM MEAL.—Findings not distinctive: delay in emptying time.

OPERATION.—Jan. 9, 1924. Paramedian laparotomy with rectus muscle retraction. The following pathological condition was found at operation: scar on anterior wall of stomach, about 1 in. from pylorus; large penetrating ulcer of duodenum on posterior wall at junction of first and second parts, spreading into pancreas; cicatricial contraction of wall of duodenum opposite to the ulcer, giving rise to deep constriction. The duodenum was prepared in the usual way, but in an attempt to remove the duodenum without opening its lumen the common bile-duct was cut right across. It is believed that the main pancreatic duct was also severed—though it could not be identified in the sclerotic mass without further dissection—because, in the section of the duodenum removed, the papilla was seen. A tube was inserted up the common bile-duct and introduced into the open end of the duodenum. The cut surface of the pancreas containing the severed ducts was implanted into this open duodenal end. The stomach was anastomosed to the jejunum, though a certain length of loop was left, as there were adhesions between the first part of the jejunum and the under surface of the transverse mesocolon.

On the fourth day the temperature rose to 101° , and on the fifth jaundice appeared, but the temperature had fallen to normal. It never rose again. By the ninth day the jaundice had disappeared, and from this date convalescence proceeded without incident.

Case 6.—J. B., male, age 45. Indigestion for five years, with intervals free from trouble, but which have gradually become shorter in duration. Pain occurred usually one hour after food. Vomiting from time to time.

BARIUM MEAL.—Much delay in emptying time of stomach; eight-hour residue considerable. Deformity of prepyloric shadow, and a persistent fleck in region of first part of duodenum. Cap never seen properly filled.

OPERATION.—Jan. 10, 1924. Paramedian laparotomy with retraction of rectus muscle. Puckered ulcer on upper wall of first part of duodenum, just beyond the pylorus, with much infiltration of gastrohepatic ligament. A number of adhesions between gall-bladder and second part of duodenum. Pylorus and first part of duodenum excised according to usual technique. There was a broad adhesion between posterior aspect of pylorus and pancreas. Axial anastomosis between stomach and duodenum.

Convalescence complicated by bronchitis during first few days following operation ; otherwise satisfactory.

Case 7.—H. S., male, age 30. History of indigestion with intervals of complete freedom for more than two years. The pain appears regularly about four hours after food. Pain made worse by exercise. Occasional vomiting.

BARIUM MEAL.—Irregularity of pyloric shadow. Small four-hour residue.

OPERATION.—Jan. 31, 1924. Paramedian laparotomy with retraction of rectus muscle. Ulcer on anterior wall of first part of duodenum, and another on posterior wall at beginning of second part. Considerable fibrosis of pancreas in neighbourhood of posterior ulcer. Duodenum freed by usual technique to a point beyond the situation of the ulcers, where it was cut across. Stomach divided $1\frac{1}{2}$ in. proximal to pylorus. End-to-end anastomosis of stomach to duodenum without clamps.

The bronchitis detectable before operation was lighted up, but the signs in chest had disappeared by the fifth day after operation. Convalescence otherwise uneventful.

Case 8.—C. L., male, age 44. Attacks of severe indigestion, with free intervals, began six and a half years ago. The pain bears no constant relation to the taking of food. Vomiting occurs during the attacks. No hæmatemesis or melæna, and appetite good.

BARIUM MEAL.—Stomach empties in average time. It is hypertonic. Duodenum not visualized distinctly. Ulcer of lesser curvature suggested.

OPERATION.—March 13, 1924. Paramedian laparotomy with retraction of rectus. When the abdomen was opened, the duodenum was found to be completely embedded in adhesions, binding to it the gall-bladder, omentum, and hepatic flexure of the colon. After separation of these adhesions, there were found to be a white scar on anterior wall of first part of duodenum ; a large ulcer on posterior wall, adherent to pancreas ; a stricture of the second part of duodenum ; and much infiltration of the gastrohepatic ligament. By the usual technique the affected segment of the duodenum was excised and joined axially to the stomach.

Convalescence uneventful.

Case 9.—G. F., male, age 29. Four years ago had severe attack of abdominal pain with vomiting. Ever since he has had constant indigestion, with only a few weeks' relief. Pain two hours after food, followed by vomiting. No hæmatemesis.

BARIUM MEAL.—Duodenum never seen properly filled ; six-hour residue considerable.

OPERATION.—March 20, 1924. Paramedian laparotomy with retraction of rectus muscle. Small ulcer on anterior wall of first part of duodenum and large sclerosed mass on posterior wall. Two adhesions between gall-bladder and duodenum. Stones felt in gall-bladder. Duodenum prepared in usual way, and ulcer-bearing area excised. End-to-end anastomosis between duodenum and stomach, which was cut across about 2 in. from pylorus. Gall-bladder opened and three stones removed. Tube sewn into gall-bladder.

Convalescence smooth. Bile drainage lasted for eighteen days.

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PAGET'S DISEASE OF THE NIPPLE.

By SIR GEORGE LENTHAL CHEATLE, LONDON.

By describing the whole sections of the breast suffering from Paget's disease of the nipple (*Fig. 205*), I add the ninth to those eight separate specimens already published in my paper entitled "Paget's Disease of the Nipple", which appeared in THE BRITISH JOURNAL OF SURGERY, Vol. XI, No. 42, 1923. It will be seen that the present example demonstrates the same problems as those I described in the previous specimens.

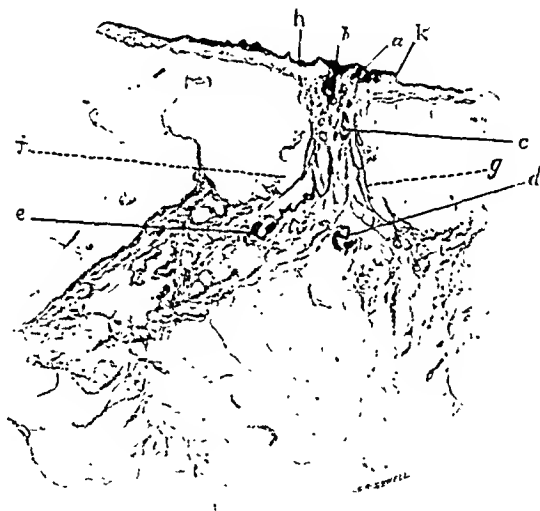


FIG. 205.—Whole section ($\frac{2}{3}$ natural size) of breast suffering from Paget's disease of the nipple, *a*, extending between the lines *h* and *k*, in a female, age 46, married; *b* is the duct in *Fig. 211*; *c* is the duct in *Fig. 206*; *d* is a lobule in *Fig. 208*; *e* is a lobule in *Fig. 210*. The dotted lines at *f* and *g* indicate lobule sections of the same breast situated deeper in the gland than *Fig. 205*, but which have not been reproduced here; *f* refers to ducts and acini in *Fig. 209*, and *g* to a terminal duct *a* in *Fig. 207*, which leads into the lobule in *Fig. 208*. There were no enlarged axillary lymphatic glands.

There are in this specimen different varieties of primary carcinoma. For instance, in direct continuity with Paget's disease on the surface is the primary carcinoma in the duct (*Fig. 206*), which, in its structure, has no characteristics of Paget's disease of the nipple. After appearing as a primary duct carcinoma, there is an interval in which the duct is free from disease until one of its terminal branches is reached at *Fig. 207*, where carcinoma of the duct is again obvious, and the duct terminates in a lobule the epithelium of which has

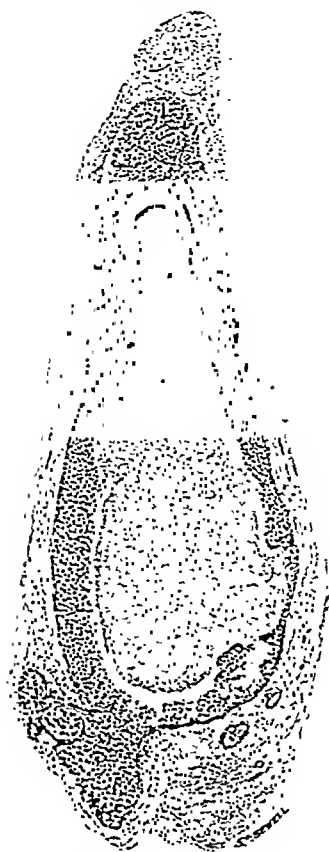


FIG. 206.—Carcinoma of duct *c* in *Fig. 205*. In other sections the epithelial cells have profoundly invaded the duct walls.

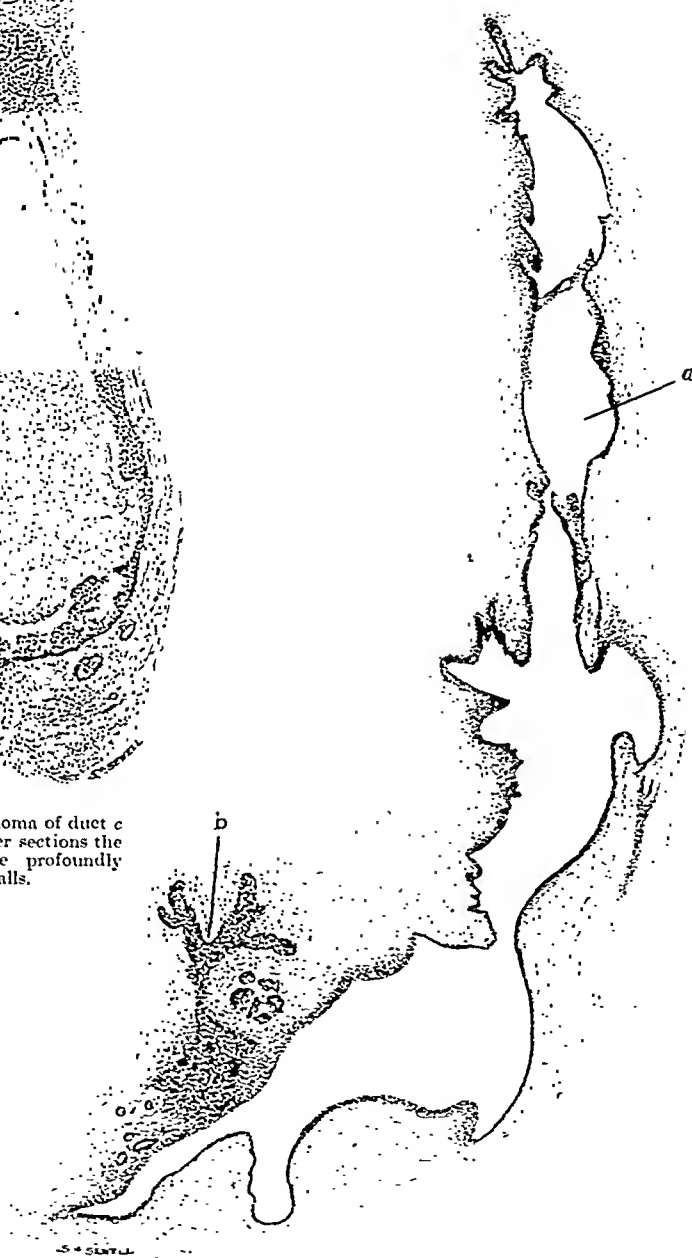


FIG. 207.—A main duct in which one of its terminals, *a*, contains duct carcinoma and leads into the lobule in *Fig. 208*. The duct is a deeper part of the duct *g* in *Fig. 205*. Carcinoma is also seen at *b*.

undergone conversion into primary acinous carcinoma (*Fig. 208*). In another duct (*Fig. 209*) is seen another primary duct carcinoma, more papillomatous in type than that in *Fig. 206*. There is acinous carcinoma in *Fig. 210*.

There is another example of similarity between this specimen and those previously published; take the duct *c* in *Fig. 205*, which is part of the duct *a* in *Fig. 207*. A long interval of the duct is free from disease, which reappears in a terminal branch of it at *b* in *Fig. 207*. The distribution



FIG. 208.—The carcinomatous lobule into which the carcinomatous duct *a* in *Fig. 207* leads, and corresponding to *d* in *Fig. 205*.

of disease in this duct is similar to that I described in this journal. Vol. XI, No. 42, *Fig. 216*, in which only the upper and terminal parts of the duct were carcinomatous.

My explanation of these facts is that the same agents that induced the primary carcinoma in the upper parts of these ducts found an easy pathway in the dilated main ducts, and were arrested in the terminal branches, where they were able to act undisturbed.



FIG. 209.—A small collection of carcinomatous terminal ducts and acini from *f* in Fig. 205. The epithelial cells in the ducts are infiltrating surrounding tissues.

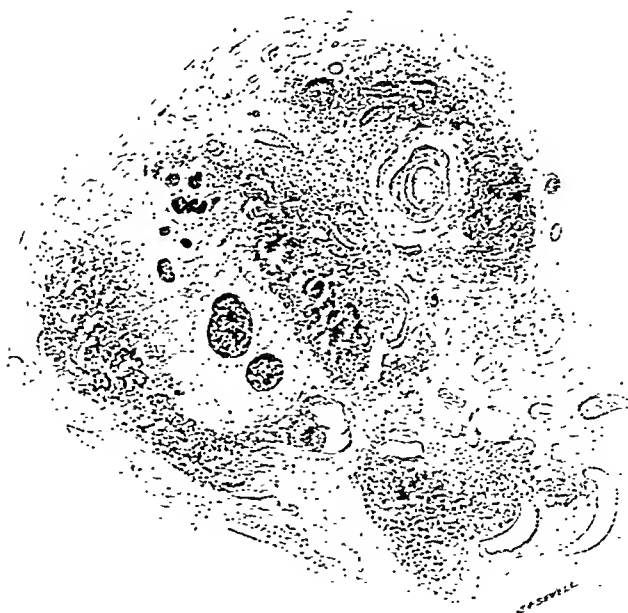


FIG. 210.—A carcinomatous lobule the exact duct connection of which I was unable to trace. The lobule is seen at *c* in Fig. 205.

Fig. 211 is a higher magnification of the upper part of a duct at *b* in *Fig. 205*. Nearly all of the epithelium lining half of the duct has undergone malignant change at *a*.

The main problem that arose in the eight specimens previously described is apparent in this ninth specimen, i.e.: Can Paget's disease of the nipple be described as a primary lesion and the changes in the breast as secondary?

Or, can these changes be described as primary and Paget's disease of the nipple secondary? Or, can Paget's disease of the nipple and changes in the breast have no connection with each other?

I have no doubt that the changes in the breast are secondary to the Paget's disease of the nipple, for many reasons. For fuller information on these points, see my article referred to above.

There are three more points to which I must allude:—

1. That there was no clinical sign of disease in this breast. The breast lesions could only have been detected by making microscopical sections of the whole breast.

2. In all the lesions I describe, the epithelial cells are not desquamative in type, but they are vigorous looking cells which—like carcinoma cells—are

living an independent existence and are not attached to any connective tissue base, through which other epithelial cells have spread in many parts.

3. In the connective tissue subjacent to the Paget's disease of the nipple, there are no lymphatic vessels containing carcinoma cells. The carcinoma in the breast is too early for this occurrence. Hence lymphatic vessels containing carcinoma cells can have nothing to do with the origin of the Paget's disease of the nipple.

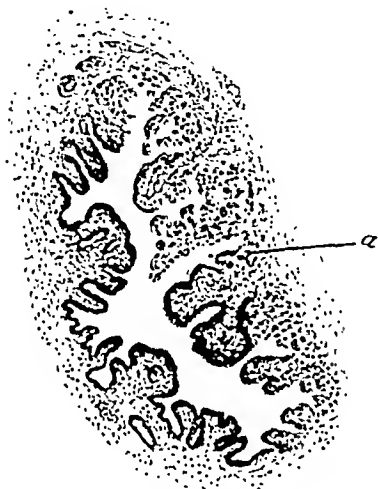


FIG. 211.—The duct *b* in *Fig. 205*. Nearly all the epithelium has undergone carcinomatous change (*a*) in one half of the duct's circumference.

THE TRANSPLANTATION OF THE FIBROUS TISSUES IN THE REPAIR OF ANATOMICAL DEFECTS.*

BY W. E. GALLIE AND A. B. LEMESURIER, TORONTO, CANADA.

AMONG the advances which have been made in the science of surgery in the past ten years the transplantation of tissues from one part of the body to another has been one of the most important. Skin-grafting is an operation which has been studied thoroughly and which has proved of the utmost value in the treatment of wounds. The transplantation of bone has been a splendid addition to our means of promoting union in fractures, although the hopes of investigators that the transplants would continue to live intact have been doomed to disappointment. Transplanted bone dies because the bone-cells are so remotely placed in their lacunæ that it is impossible for lymph to reach them. Only those cells which lie on the surfaces of the transplant and in the open mouths of the Haversian canals and which have not yet become enclosed in lacunæ continue to live. Fortunately, the success of a bone-graft does not depend altogether on the survival of the cells, and despite the fact that most of the graft dies, it still serves as a valuable assistant in bringing about union in fractures. In the case of the fibrous tissues, however, there is no such peculiar arrangement of the cells within impermeable walls. They lie irregularly scattered among the fibres and are so accessible that even after transplantation of the tissue they are able to get sufficient nourishment from the bathing lymph to survive the operation. Many investigators have reported that these tissues may be transplanted with the full expectation that they will continue to live, and to live practically unchanged.

Before embarking on the investigation which forms the basis of this paper, we conducted a series of simple experiments on animals which completely corroborated the findings of these investigators. The animals used were rabbits, and the experiments consisted of operations in which patches of fascia, tendon, and aponeurosis were excised and immediately sewn back in their original positions. The specimens were recovered at intervals ranging from a few days to many weeks.

During the first few weeks the specimens showed the ordinary phenomena of inflammation. At first the blood-vessels in the tissues surrounding the transplants were much engorged and the whole area was covered with plastic exudate. Very soon a thin transparent film developed over the transplant, consisting of capillary blood-vessels and fibroblasts. This film rapidly

* The Hunterian lecture delivered at the Royal College of Surgeons of England on April 30, 1924, by W. E. Gallie, was based on the material contained in this paper. The experimental investigations involved were conducted in the research laboratories of the University of Toronto.

increased in thickness, and, by the end of the third week, had developed into a mass of spindle-shaped cells and fibres. The blood-vessels in this film

increased in size at a corresponding rate until they could be seen with the naked eye, running across the line of suture. During this time the transplant remained alive, and showed, on microscopic examination, very little change beyond a moderate oedema. Its outline remained distinct, without any evidence of invasion by new blood-vessels or connective tissue and without any leucocytic infiltration. The fibres and cells continued to stain well. (Figs. 212, 213.)

After the third week the inflammatory phenomena gradually subsided. The hyperæmia and oedema slowly disappeared, and the film on the surface became as thin and transparent as the layer of areolar tissue on the surface of normal fascia. In specimens re-

covered as late as a year after the operation there was nothing to indicate that the cells or fibres had been changed in any way or that their physiological value had been influenced by the transplantation (Fig. 214).

These experiments were repeated many times, and always gave the same results, with the exception that when thick pieces of tendon were transplanted necrosis sometimes occurred in the deeper portions. This can be prevented by making a number of longitudinal incisions in the transplant through which the lymph may reach the cells in the interior.

Thoroughly convinced that the fibrous tissues are suitable for transplantation and that they can be expected to remain unchanged for long periods of time, we turned our attention to a study of the purposes for which they may be transplanted, and of the manner in which the operations must be performed to ensure the

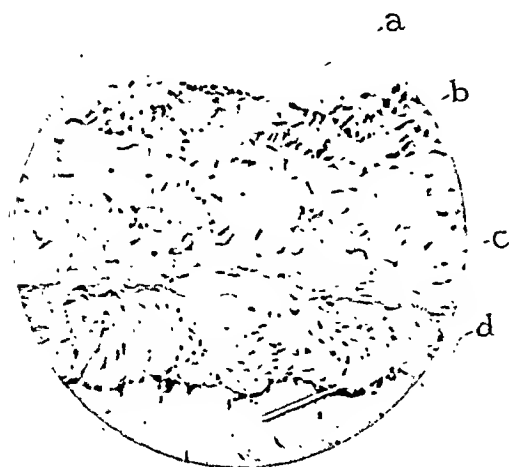


FIG. 212.—Normal fascia and aponeurosis from rabbit's back, showing arrangement of fibres and cells. (High power.) *a*, Vascular areolar tissue on surface; *b*, Deep fascia of back; *c*, Aponeurosis; *d*, Muscle.

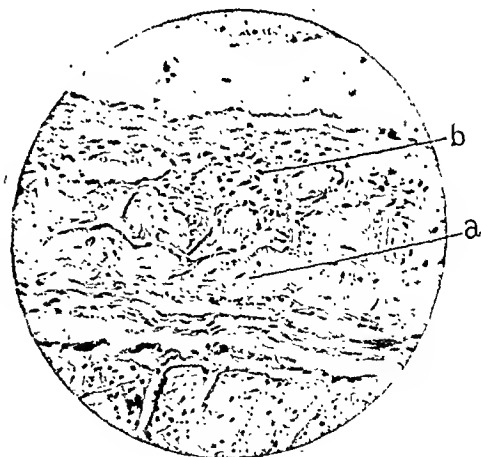


FIG. 213.—Fascial transplant recovered after three weeks. (High power.) *a*, Fascial transplant; *b*, Thick film of very vascular new areolar tissue on surface.

desired results. From time to time reports of successful transplantations of fascia lata for the repair of anatomical defects have appeared in the medical literature, but as far as we know there have been no investigations of how these successes were accomplished, and no statement of the rules which must be adopted to avoid the possibility of failure. That failures occur is unfortunately true, and they have been so frequent that the transplantation of fascia has never come into very general use. In the treatment of large ventral hernias and of direct inguinal hernias, for example, the filling of the defects with patches of fascia lata has been often described; and yet one rarely hears, nowadays, of the operation being performed.

The failures have been attributed usually to the supposed necrosis and absorption of the grafts. This explanation may in some cases be perfectly correct, for it is easy to imagine that if the transplants are placed in such a position that a free supply of lymph is not available, as, for example, in a mass of scar-tissue, necrosis and absorption might occur. The perfect regularity, however, with which success is attained in experiments on animals, and the practically complete absence of failures which has attended our own clinical work, have led us to believe that necrosis of the transplant is not the real explanation of failure.

Some years ago, in a study of the fixation of tendons to periosteum and bone, we were struck with the amount of precaution which must be taken to secure an adhesion of one structure to the other sufficiently strong to withstand ordinary physiological strain.

We found that in attempting to prevent the deformities of infantile paralysis in the feet by fixing the tendons of the paralysed muscles to the bone, it was necessary to bury the thoroughly scarified tendon in a groove or tunnel for a considerable distance before solid union could be assured. Further, the surfaces of the tendon must be held firmly in contact with the walls of the tunnel for six or eight weeks. If any of the details of the operation were neglected, such as the complete removal of the areolar coverings of the tendon, and the scarification of its surface, failure of the fixation was the invariable result. Histological examination of specimens recovered at a later date clearly showed that the fixation of the tendon to the bone depended solely on scar-tissue, and that unless this scar-tissue were continuous with the connective tissue in the interior of the tendon, through wounds produced in its surface, and unless the section of tendon buried in the bone were from one to three inches in length, depending on the strain to

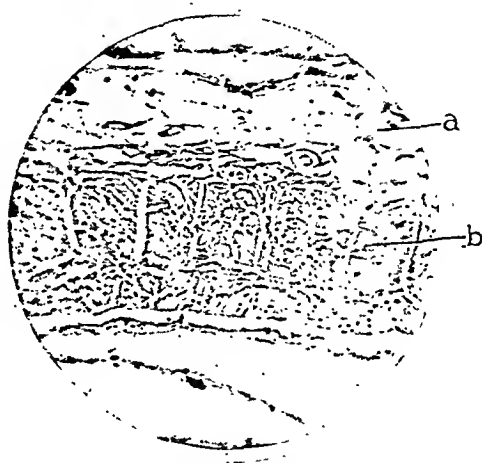


FIG. 214.—Fascial transplant recovered after thirteen months. (High power.) *a*, Areolar tissue on surface with normal blood-supply; *b*, Fascial transplant.

which the tendon would be subjected, the scar-tissue always gave way or stretched, and the deformity recurred. These observations caused us to suspect that the failures following the transplantation of tendon and fascia might be accounted for in a similar way, and ultimately led to a series of experiments on animals which have amply confirmed the suspicion.

The first series of experiments was concerned with the simple healing in the fibrous tissues. Incisions were made longitudinally and transversely in tendon, fascia, and aponeurosis, and sutured in various ways with catgut and fine silk. The specimens were recovered at intervals. When the line of incision was subjected to very little strain, as in the longitudinal splitting of a tendon or of the fascia lata, the wound healed perfectly, and in a few months could not be found either by naked-eye or microscopical examination. When the ordinary movements of the animal, however, caused a strain upon the line of incision, very different results were produced. Sometimes, as in longitudinal incisions in the middle line of the abdomen, the scar which formed was only slightly stretched. In others, as in transverse incisions through tendons and aponeuroses, the wound gave way completely and was covered only by the stretched-out areolar membranes which are normally on the surfaces of these structures. If the edges of the incision were simply drawn together into edge-to-edge apposition with an absorbable suture, the tendency to separation was greatest; but even when silk was used, although the amount of scar-tissue was increased, the stitches frequently cut out and the wound stretched open. This tendency to opening of the wound was very decidedly lessened by scraping off the areolar sheaths, and overlapping the edges. The scraping of the surfaces was of the utmost importance, as without it the simple overlapping did no good whatever. Microscopical examination showed that when the sheath was scraped away the overlapped edges healed by a scar which was intimately attached to them, whereas, when the areolar tissues were left in place, the healing simply consisted of a light adhesion of the areolar tissue on one edge of the wound to that on the other. Even when these precautions were taken, however, if the wounds were subjected to severe or long-continued strain they frequently opened up.

These observations made on animals agree fully with clinical experience. Examples of defective healing in wounds of the fibrous tissues are readily available. Thus, subcutaneous tenotomy, which at one time was very generally employed, has been demonstrated to be a dangerous operation owing to the tendency of the scar which forms between the ends of the tendon to stretch. It has been replaced, almost completely, by some other form of tendon-lengthening. The frequency of hernia through incisions in the linea semilunaris has forced the abandonment of this approach to the abdominal cavity. And the uncertainty attending attempts to close large umbilical and post-operative ventral hernias is too well known to admit of doubt in regard to the nature of the healing.

A second series of experiments was devoted to a study of the character of the healing which takes place between transplants and the tissues to which they are sewn. In one group patches of fascia were removed from the animals' backs and sewn into place again by the various methods used in everyday surgical practice. In another group segments of tendon were cut free and

similarly replaced. The specimens were recovered as before at regular intervals up to many months.

A study of the specimens obtained in these experiments confirmed completely our suspicions as to the cause of failures after transplantation of the fibrous tissues. Healing of a transplant to the tissues to which it is sewn takes place exactly as in the healing of a simple wound of the fibrous tissues. The fact that the transplant has been cut free from the circulation appears to have no influence on the character of the healing. If the line of contact is under only slight tension satisfactory union occurs, but if the scar is subjected to prolonged or severe strain the line of suture opens up and the final result is a failure. Simple edge-to-edge suture of fascia or aponeurosis and end-to-end suture of tendon give the highest percentage of failures. Careful scraping and overlapping of the edges which are in contact greatly increase the strength of the union, but even here the success of the operation depends entirely on the strain to which the line of suture is subjected. Non-absorbable sutures add to the strength of the union by increasing the amount of scar tissue and by supporting part of the strain themselves, but, as in the case of simple wounds, they frequently cut out and the same result follows as when absorbable sutures are used. (Figs. 215, 216.)

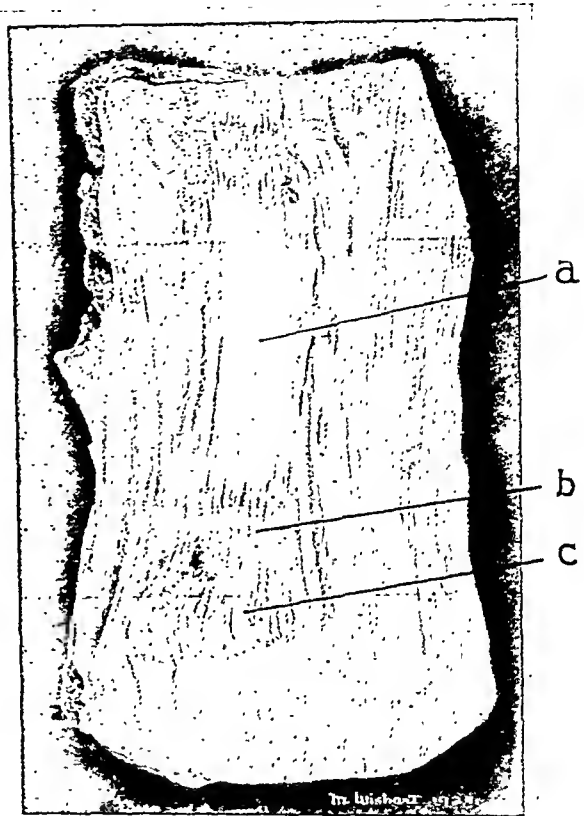


FIG. 215.—Drawing of patch-transplant of aponeurosis recovered after thirteen months. At the operation the transplant was accurately sutured all around its edge to the normal aponeurosis. Union has taken place by the formation of weak scar-tissue which has stretched considerably. *a*, Aponeurotic transplant; *b*, Thin film of new tissue uniting *a* and *c*; *c*, Edge of normal aponeurosis.

In a third series of experiments we investigated the healing of transplants of tendon and fascia to bone. The results indicated that the nature of the healing is exactly similar to that which occurs when a tendon is transferred to a new insertion. If the transplant is simply sewn to the periosteum, or placed under it, or laid in a groove in the bone for a short distance, it very soon pulls away after strain is applied, owing to the weakness of the scar-tissue which forms the bond of union. To make certain of a permanent

fixation it is necessary to scarify the surface of the transplant and to place it in close apposition with raw bone for a considerable distance, from one to three inches, depending on the anticipated strain. If it is intended to bury the tendon in a groove, the most certain method of fixation is to split it into several tails and to pack it into the groove along with slivers of the bone removed with the gouge. The periosteum is sewn over all. In this way the surfaces to which adhesions will take place are greatly increased and the scar-tissue is carried into the depths of the transplant. The most generally useful method of fixation, however, is to pass the end of the transplant, which has been split into tails, through a drill-hole in the bone, and to fix it there by some form of absorbable suture which will hold it in place till healing occurs.

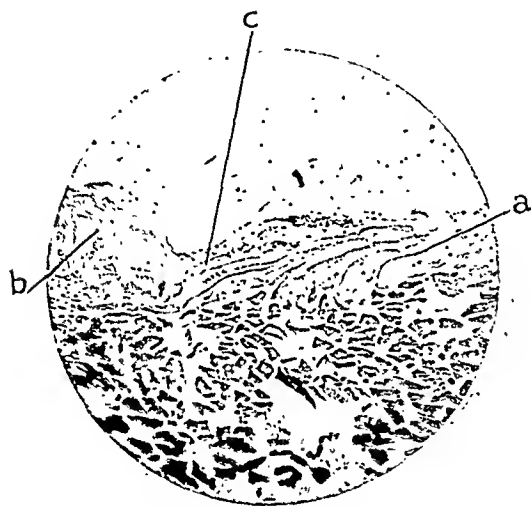


FIG. 216.—Line of union between aponeurotic transplant and normal aponeurosis after thirteen months. (High power.) *a*, Aponeurotic transplant; *b*, Normal aponeurosis; *c*, New scar-tissue between the two.

These simple experiments have been useful in fixing our attention on the weak point of the usual methods of filling anatomical defects with transplants of the fibrous tissues. Evidently edge-to-edge suture of aponeurosis or fascia should only be done where the tissues can be brought together without tension, and where the subsequent physiological strain will be slight. It will be rare indeed to find an occasion in which this method will be useful in sewing in a transplant. The experiments indicate that, in practically all cases where transplants are required, it is necessary to overlap the edges freely and to scrape and scarify the surfaces which are placed in apposition, before firm healing can be expected.

Silk or linen would appear to be the suture material of choice.

The objections to these refinements of technique are considerable. In the first place, many surgeons, in common with ourselves, hesitate to use non-absorbable sutures owing to the frequency with which they set up late irritation. In the second place, the operation is made long and difficult, and the additional handling of the tissues adds to the chances of infection of the wound. And, lastly, the precautions by no means eliminate the possibility of separation of the wound, as, after all, the union is dependent on scar.

In thinking over various means of getting rid of these objections, it occurred to us that it might be possible to eliminate the patch-transplant altogether, and replace it by living sutures made from fascia lata. To test this idea, a series of experiments was performed in which strips of fascia a quarter of an inch wide and about six inches long were removed from the rabbits' backs, and, after being threaded on a needle, were used to sew together

the edges of the gap left by their removal. The edges were not drawn into apposition but were left apart, so that the whole strain would come on the suture and not on any scar-tissue which might form in the line of union. To test the effect of the operation on the strength of the sutures, we made a rough estimate, by means of a special machine, of their tensile strength at the time of the operation and again when the specimen was recovered. We also studied the question of stretching or contraction of the suture by attaching to it at accurately measured intervals two black silk threads to act as markers. The distance between these markers was measured again when the specimen was examined. The specimens were recovered at intervals from a few days to two years after the operation.

The changes which occurred in the sutures agreed accurately with those already described in the case of patch-transplants. A few days after the



FIG. 218.—Drawing of living suture of fascia, recovered thirteen weeks after insertion in rabbit's back. The suture is now a rounded glistening cord which closely resembles tendon.

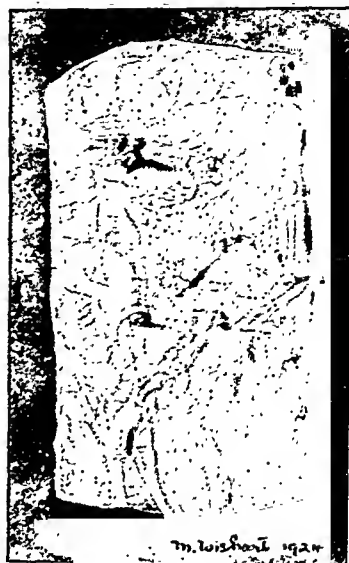


FIG. 217.—Drawing of living suture of fascia, recovered three weeks after its insertion in rabbit's back. On the upper stitch are shown the two black silk markers used to test the effect of the operation on the length of the suture. Dilated blood-vessels can be seen traversing the area in the areolar film which forms over the suture.

operation the surrounding tissues were hyperæmic and the whole area was covered with a thin layer of exudate. The suture was distinctly swollen. At the end of a week minute new blood-vessels could be seen spreading through the film on the surface of the suture; these increased in size until towards the end of the third week, by which time the film of exudate had been converted into ordinary areolar tissue.

As a result of following the needle through the needle-holes the suture had been folded longitudinally. It was completely surrounded by the new film of areolar tissue, which sent processes with new blood-vessels between the folds. A cross-section made at the end

of the third week shows the suture folded loosely together and completely surrounded with areolar tissue, which extends inward among the folds like the stroma of one of the glandular organs. The cells and fibres of the suture itself remained unchanged. During the succeeding weeks the inflammatory reaction subsides and the œdema disappears. The suture shrinks until it appears like a glistening white tendinous cord. In longitudinal section it looks like normal fasciæ, and in cross-section it closely resembles tendon.

The folds are now so closely pressed together that they can be scarcely recognized, and the processes of areolar tissue which extend among the folds have become so thinned out as to resemble the normal connective-tissue stroma of a tendon. Surrounding the whole is an areolar film from which the stroma with its blood-vessels passes into the cord. Specimens recovered after the lapse of many months appear to have undergone no further change. No stretching or contracture occurs, and the strength of the suture is approximately the same as at the time of operation (*Figs. 217-225*).

The effectiveness of strips of fasciæ as sutures is fully demonstrated by the specimens. It appears to be necessary only to anchor the suture securely at its two ex-

FIG. 219.—Drawing of living suture of fasciæ, recovered two years after insertion in rabbit's back. It does not appear to have been changed by the lapse of time.

tremities and to make sure of getting a good grip of the edges of the gap in the fasciæ to hold them permanently in their original position. The superiority of the suture over absorbable material is self-evident, and over linen, silk, or silver wire it has the advantage that it has no tendency to cut out or to set up irritation of any kind. Unlike these materials, it heals to the edges of the defect at the points where the needle passes through them.

The idea of using strips of the fibrous tissues as living sutures appears to have solved the uncertainty which attended the use of patch-transplants.

FIG. 220.—Cross-section of portion of fascial suture after three weeks. (Low power.) *a*, Folds of fascia; *b*, New connective tissue surrounding the whole suture and extending into the spaces between the fascial folds.

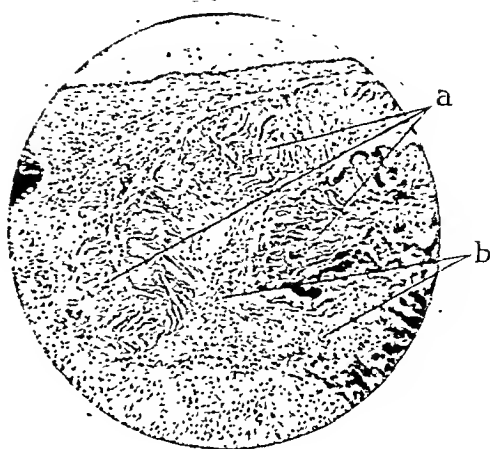
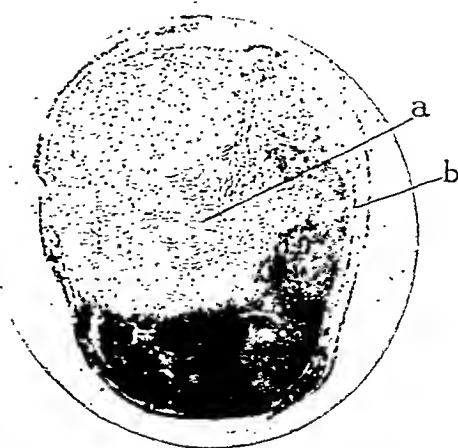


FIG. 221.—High-power photograph of same section as shown in Fig. 220. The cells of the fascia are stained well, the outline of each fold is distinct, and there is no invasion of the fascia itself by new tissue. *a*, Folds of fascia; *b*, New tissue between the folds.

FIG. 222.—Cross-section of fascial suture after six weeks. (Low power.) The suture is now a rounded cord. The separate folds can no longer be distinguished, and the new tissue between them is represented merely by narrow trabeculae of connective tissue. *a*, Rounded cord of fascial suture; *b*, Vascular areolar tissue.



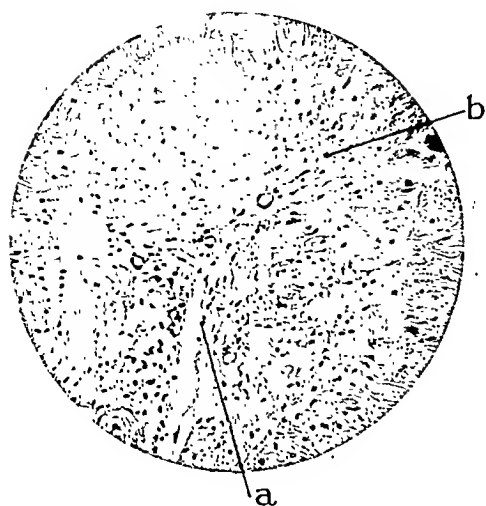


FIG. 223.—High-power photograph of same section as shown in *Fig. 222*. *a*, Connective tissue between the folds of fascia: *b*, Fascia, which is obviously alive and resembles normal fascia in every way.

FIG. 224.—Longitudinal section of fascial suture after six weeks, showing the persistence of the normal parallel arrangement of the fibres. (High power.)



FIG. 225.—Cross-section of fascial suture after two years. (Low power.) It is still in the form of a rounded cord, and shows no appreciable change from the six-weeks' suture depicted in *Fig. 222*.

In the latter the whole success of the operation depends on the character of the healing of the transplant to the tissues to which it is sewn, whereas, in the former, this doubtful factor is completely removed and the whole test of the effectiveness of the operation falls on the transplant itself. If this lives and remains unchanged, and experimental evidence seems to demonstrate this, there is no reason why a great variety of anatomical defects should not yield to fibrous tissue transplantation.

CLINICAL APPLICATIONS.

Since the commencement of our experiments, we have had ample opportunity, both in military and civilian practice, to test clinically the principles outlined. For purposes of description the cases may be grouped as follows: (1) *Injuries to Tendons*; (2) *Injuries to Ligaments*; (3) *Certain Ununited Fractures*; (4) *Paralytic Deformities*; (5) *Facial Paralysis*; (6) *Ptosis of Viscera*; (7) *Hernia*.

1. INJURIES TO TENDONS.

Of these we have had a great variety, usually wounds of tendons which have failed to unite and in which contracture of the muscle has made it impossible to bring the ends of the tendon into apposition. The cases include several in which transverse wounds on the palmar aspect of the wrist have divided all the structures from the skin to the bone. The majority, however, have been cases of ununited wounds of one or more important tendons. How these cases shall be dealt with depends on the amount of strain the tendon is normally called upon to withstand. To fill the gap with a transplant of tendon or fascia placed in neat end-to-end apposition seems to us to be too uncertain a method to merit consideration. Failures or partial failures owing to stretching of the scar are very frequent. The strength of the union can be increased by bevelling the ends where they are in contact and thus enlarging the area of the raw surfaces which are opposed to one another. Since the idea of living sutures suggested itself, however, we have employed these on nearly all occasions. An example will illustrate the manner of their use.

A butcher was admitted to hospital with a marked disability of the hand which had resulted from a knife wound, six months previously, through the thick of the thumb. The flexor longus pollicis had been severed, and the cut ends were widely separated. The ends of the tendon were exposed by two incisions, one along the inner border of the short muscles of the thumb, and another above the wrist. They were drawn together as closely as possible, but a gap of three-quarters of an inch still persisted. A thin strip was then cut from the tendon of the palmaris longus, about four inches in length and one-sixteenth of an inch thick, and threaded on a needle. It was tied into the needle with fine silk, and a catgut ligature fastened around its terminal end to prevent fraying. Without freshening the ends of the severed tendon in any way they were woven together with the living suture, much as one splices a rope, or, better, laces a leather belt. The suture was first anchored in the end of the tendon nearest the muscle by passing the needle into the side and out of the end of the tendon and then through the tail of the suture. In

this way a firm slip-knot was made which could not cut out owing to the scar-tissue on the end of the severed tendon. The suture was then carried backward and forward across the gap, making sure to get a good grip of the ends of the tendon, until the suture was used up. It was finally anchored by splitting the tail into two strands and tying them together in a triple knot around one of the loops of the suture. The knot was secured against untying by transfixing and tying it with a catgut ligature. The patient commenced active movements of the thumb in three weeks, and returned to his work in two months. It is now four years since the operation, and he has perfect function in the thumb.

The advantages which we see in the method are several. In the first place, it is simple and easy of execution. In the second place, it allows the cut ends of the tendon to be drawn together under strong tension, and thus restores the muscle as closely as possible to its normal length; this is of importance if the normal power and range of motion are to be restored. And lastly, it eliminates the element of chance which attends healing by scar-tissue, and places the whole responsibility for union upon the transplant itself and on the manner in which it is woven into the ends of the tendon.

Injuries to Tendons which normally are Subjected to great Strain.—

Ligamentum Patellæ.—While the method described above has proved perfectly satisfactory in bridging gaps in ordinary tendons such as those of the forearm, we have hesitated to trust to it in wounds of such powerful tendons as the ligamentum patellæ. Of this latter condition we have had four cases; one in which the tendon had been ruptured at its middle, about a year previously, by a fall on an iron radiator; one in which the tendon had been evulsed from its insertion and failed to unite to the bone after prolonged fixation; one in which the tendon had not united firmly after suture with catgut following a transverse operative incision into the knee-joint; and one in which the tendon had been forcibly torn from the patella, carrying with it a small flake of the bone. Each of the cases came into our hands a year or more after the accident, and showed such a degree of disability through absence of power to extend the knee that operative treatment was required. In all of the patients the patella was held high above the condyles of the femur and there seemed to be little prospect of drawing it down to its normal position. We were consequently faced with the necessity of bridging a gap with a transplant and at the same time making the repair so strong that it would withstand tremendous degrees of strain. After some consideration an operation was devised which has proved satisfactory in all four cases and can be employed equally well in all types of the injury.

Through an S-shaped incision on the front of the knee-joint, the patella, the remains of the injured tendon, and the tubercle of the tibia are freely exposed. The pieces of the tendon are split longitudinally in the middle line, from the patella to the tubercle. With a $\frac{3}{16}$ -in. drill two holes are bored through the patella from the upper to the lower border. At the upper border these drill holes are about one inch apart, and at the lower about half an inch. At the lower border, therefore, when the drill has passed through the bone, it enters the remains of the ligamentum patellæ. It is pushed steadily onward until its point appears in the median incision in the old tendon. A $\frac{3}{8}$ -in. drill is now applied to the tubercle of the tibia, and a deep hole is bored obliquely

downward into the bone. A $\frac{3}{16}$ -in. drill is then applied to points on the internal and external surfaces of the tibia about an inch below the hole in the tubercle, and holes are bored which incline obliquely upward to meet the large hole in the depths of the bone. At this stage the patient is turned on his side and the tendo Achillis of the same leg exposed. A segment of this tendon, composed of half its thickness and about seven inches long, is removed and

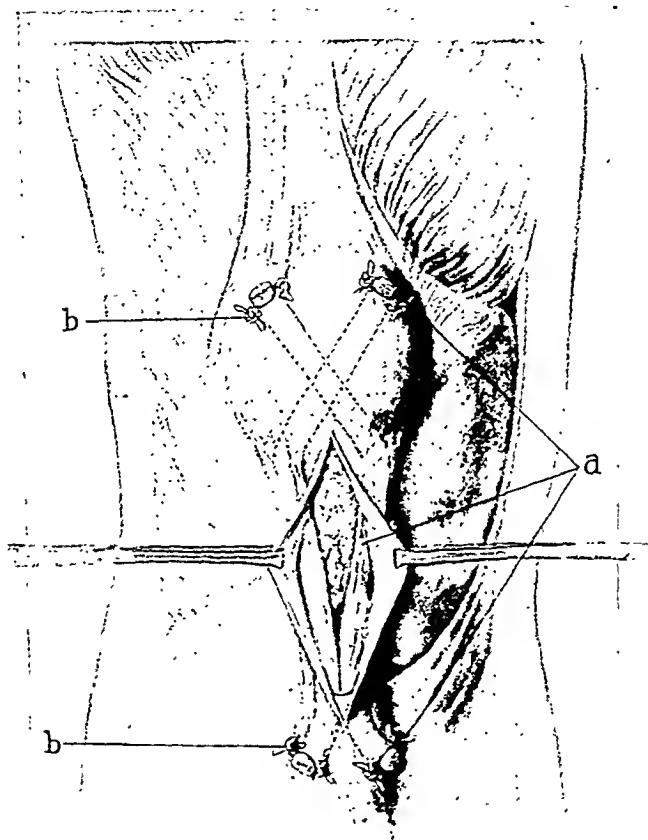


FIG. 226.—Drawing of operation for the repair of ruptured ligamentum patellæ.
a, Segment of tendo Achillis drawn through holes in patella and tibia b, Kangaroo sutures which fasten the transplant in place until firm healing occurs.

split into two equal parts. All areolar tissue is carefully scraped away, and—from above downward—the transplants are threaded through the holes in the patella into the large hole in the tubercle of the tibia and out through the small holes in its internal and external surfaces. The patella is then dragged downward with sharp-hooked retractors as far as it can be induced to come, and the new tendons are pulled taut and sutured together and to the

neighbouring periosteum with kangaroo tendon. This suturing must be done thoroughly, as upon it depends the anchoring of the patella until the new tendons become firmly healed to the bone. As the total cross-section of the transplanted tendon is considerably less than that of a normal ligamentum patellæ, we have thought it wise to give additional strength to the repair by bridging the gap in the old tendon by a living suture made from the tendon of the plantaris longus, or, if the rupture has taken place at the attachment to the tibia or patella, by weaving the living suture into the end of the tendon and through the holes in the bone. The old and new tendons are finally sewn



FIG. 227.—Photographs (a, b, c) of patient operated upon five years ago for rupture of the ligamentum patellæ. They show the range of voluntary movement to be normal, and give some idea of the power in the extensors.

together into a compact mass with catgut. (*Fig. 226.*) The limb is encased in plaster-of-Paris for about eight weeks, after which active movements are begun.

This operation has so far proved entirely satisfactory. All four patients are workmen who are engaged in laborious occupations. The first patient, a bricklayer, was operated on five years ago. The others were operated on four, two, and one year ago respectively. They have no disabilities whatever. (*Fig. 227.*)

Rupture of the Quadriceps Tendon.—There have been two cases of rupture of the quadriceps tendon at its attachment to the patella, which had at first seemed to be healed firmly, but in which the scar ultimately became stretched. These were treated by suturing the end of the tendon to the patella with several

mattress sutures of fascia lata. They were woven securely into the tendon and then passed through vertical holes in the patella. The ends were woven into each other and sutured with catgut. No preliminary dissection of the end of the quadriceps was done for fear that it might lead to cutting out of the sutures. These patients have been walking for about a year and have no disability.

Ununited Wounds of the Tendo Achillis.—This not very uncommon condition lends itself well to treatment with living sutures. The type of operation required will depend on the nature of the injury, but the presence of the plantaris tendon in the neighbourhood makes the problem easy. This tendon makes an ideal suture, as it is so slender that it may be used in place of catgut to sew together the freshened ends of the tendo Achillis if these can be overlapped, and it is so strong that it may be used to bridge a gap when the ends of the severed tendon cannot be brought together.

Our first patient was a young man who had received a wound in the middle of the tendo Achillis some months previously, and in whom the scar had become so stretched that he had no power to plantar-flex the foot. The operation consisted of a dissection of the ends of the tendon, with removal of the scar, so that they could be overlapped. They were then sewn solidly together with sutures made by splitting the plantaris tendon into two strands. The result was excellent.

We have at present under observation a patient who two years ago ruptured his tendo Achillis at its attachment to the os calcis. He was treated by prolonged fixation of the foot in the equinus position, but the subsequent strain of walking separated the tendon from the bone or so elongated the scar that the plantar-flexor power of the foot was lost. We propose to repair the defect by splitting the tendo Achillis as in a tendon-lengthening operation and using half of it as a free transplant. This will be passed through a hole in the os calcis and anchored there with catgut. The two halves of the tendon will then be sewn together with a 3-in. to 3½-in. overlap. If it seems advisable the plantaris tendon will be used as a living suture to reinforce the repair.

Up to the present all the cases of injuries of tendons that have been treated with transplants of tendon or fascia had been under treatment for several months before operation. We have not had occasion to treat a case at the time of the accident. We are so convinced, however, that the healing of such structures as the ligamentum patellæ and the tendon of the quadriceps is unlikely to prove sufficiently strong to stand the strain of normal activity, that, when the occasion arises, we shall attempt to repair the damage immediately by some form of fascial transplant or by living suture.

2. INJURIES TO LIGAMENTS.

Habitual Dislocation of Patella.—It is rare that injuries to ligaments require operative treatment. Yet in ligaments, as in tendons, firm healing does not always take place. As a result, dislocations are likely to recur and become exceedingly troublesome. Our attention was first drawn to the condition in 1917 when a soldier was admitted to military hospital with a lateral dislocation of the patella. His history was that a year previously the

patella had been dislocated during a collapse of a dug-out. The treatment had consisted of immobilization of the limb in full extension for several weeks. Two months later the displacement recurred during sudden bending of the knee. A plication of the inner portion of the capsule with catgut was then performed, but within four months the dislocation had recurred again. After this last recurrence it was found that the patella would slip outward over the condyle as soon as the pressure of the hand was removed from it. In view of this, further treatment was abandoned. When he came under our observation the patella was lying on the lateral aspect of the lower end of the femur and could not be dislodged from this position. The man walked only with crutches, and complained of great pain whenever the joint was moved. The cause of the recurrence of the dislocation was the marked degree of knock-knee which was present.

The following operation was performed: The patella was freed of adhesions by dissection and forcibly lifted back into the intercondylar notch. Through a vertical incision on the inner side of the joint the inner border of the patella and the internal condyle were exposed. A transverse hole was then drilled through the widest portion of the patella with a $\frac{1}{4}$ -in. drill, and two other holes, separated by about an inch, were bored in the internal condyle so that they met in the depths of the bone. A segment of the tendo Achillis composed of half its thickness and about seven inches long was then removed and passed through the hole in the patella, into one of the holes in the condyle, and out of the other. The patella was drawn as far inward with a hooked retractor as it would come, and the new ligament was drawn taut and anchored to the patella and the condyle with kangaroo sutures. The wounds were closed and the limb encased in plaster-of-Paris, which was moulded against the outer side of the patella to prevent recurrence of the displacement if the sutures should loosen. Massage and movements were commenced in about seven weeks, and after three months the patient was discharged cured. He was examined a few months ago, six years after his operation, and reported that ever since he was discharged from hospital he has been at work without disability as a motor mechanic. During flexion and extension of the knee the new ligament can be felt and seen standing out like a whip-cord between the patella and the condyle. (*Fig. 228.*)

Habitual dislocation of the patella is much more common than we had supposed. Since the operation just described we have seen seven cases, all occurring in girls and young women, without any predisposing cause other than relaxed ligaments. It is an exceedingly annoying condition, as the displacement is liable to occur most unexpectedly, and always produces great pain and sometimes serious falls. Many operations have been designed to overcome it, but few have been completely satisfactory.

One method in particular deserves criticism, namely plication of the capsule. When one remembers the nature of the healing that occurs in wounds of the fibrous tissues, the futility of pleating an uninjured ligament, such as the capsule of a joint, with catgut sutures, must be apparent. To illustrate this point we did a few experiments in which the fascia of the back in rabbits was plicated with catgut and various other suture materials. In some the areolar covering was left undisturbed, but in others it was carefully

seraped away and the fascia scarified. Invariably the folds disappeared after a few weeks and nothing was left to indicate that any operation had been performed. Plication of the fascia with a living suture, on the other hand, is permanent, and suggests at once that if one desires to plicate the capsule of a joint, a suture of tendon or fascia lata should be employed.

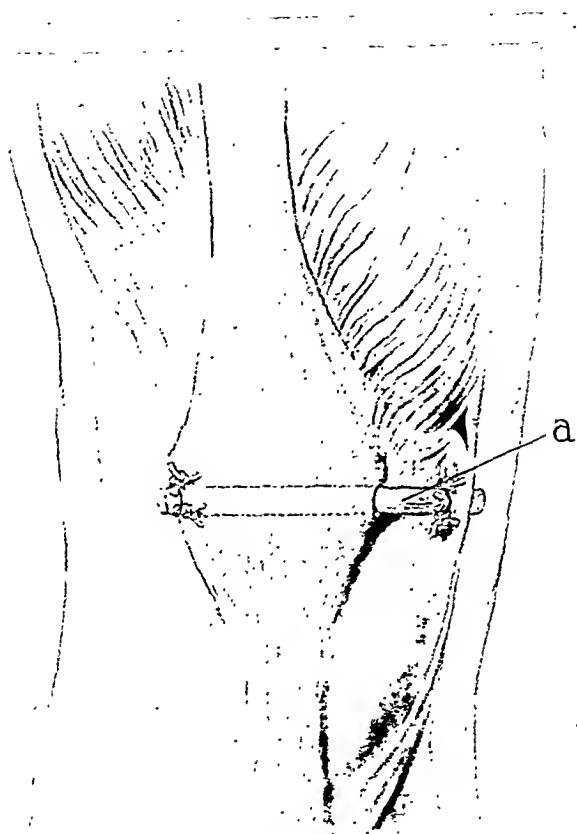


FIG. 228.—Drawing of operation for recurring lateral dislocation of the patella in which great force is required to prevent the displacement. *a*, Segment of tendo Achillis passed through holes in the patella and internal condyle and fastened in place with kangaroo sutures.

For habitual dislocation of the patella, however, we have not trusted to plication of the capsule, as it is such an easy matter to tether the patella to the condyle without disturbing the ligament. The operation resembles that performed on the soldier described above, except that fascia lata is substituted for the tendo Achillis. Through two short incisions, one on either side of the patella, two holes are drilled transversely through the bone. Through another short incision over the internal condyle two holes are drilled into the femur,

which meet in the depths of the bone. A strip of fascia lata, half to three quarters of an inch in width and ten inches long, is obtained from the lateral aspect of the thigh and firmly ligated at each extremity with strong silk. With the assistance of the silk the strip of fascia is drawn from without inward through the holes in the patella so as to form a loop along its outer border. A pair of artery clamps is then passed subcutaneously from the incision over

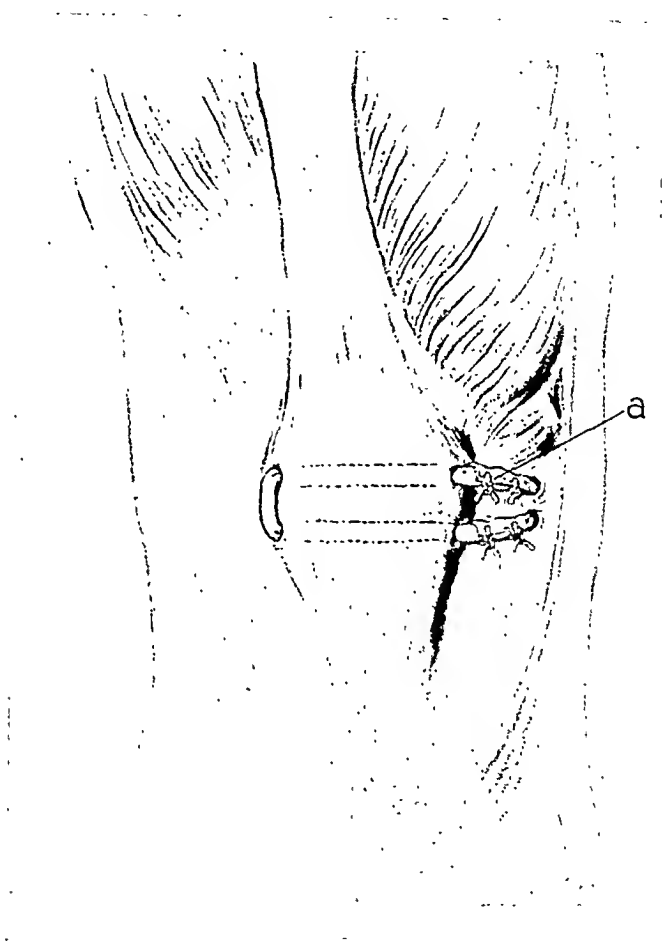


FIG. 229.—Drawing of operation for habitual dislocation of the patella. *a*, Strand of fascia lata, half an inch wide, passed through holes in the patella and internal condyle and fastened with catgut.

the condyle to the incision on the inner side of the patella, and the ends of the fascia are drawn through the subcutaneous tunnel. Again utilizing the silk, the ends of the fascia are drawn through the holes in the internal condyle and pulled sufficiently taut to hold the patella firmly inward. The overlapped portions of the fascia are then freed of areolar tissue and woven through one another once or twice and sutured together with catgut. The silk ligatures are finally removed and the wounds closed. A plaster bandage

is applied from the toes to the upper portion of the thigh with the knee in full extension. (*Fig. 229.*)

The subsequent history of these seven patients has been satisfactory. Movements of the knee were commenced after six weeks, and within a few weeks more the function of the joint was normal. In none of the cases has there been a recurrence of the dislocation.

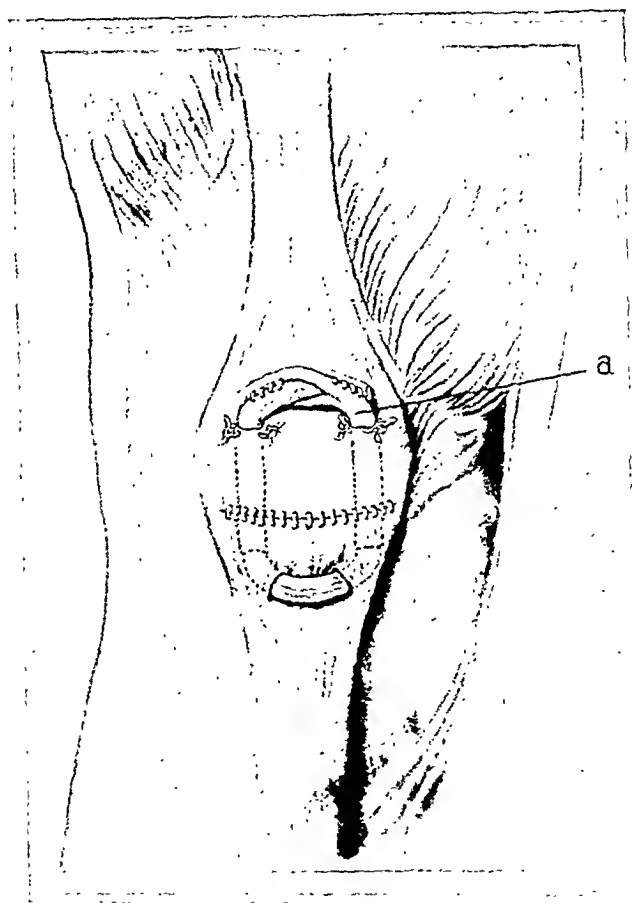


FIG. 230.—Drawing of operation for repair of ununited fracture of patella in which one of the fragments is a mere flake of bone. *a*, Heavy suture of fascia lata passed vertically through the patella and transversely through the ligamentum patellæ.

Recurring Dislocation of the Shoulder.—The observation that fibrous structures such as the capsules of joints may be plicated successfully, if narrow sutures of fascia lata are used, suggests at once that recurring dislocation of the shoulder might be effectively treated by this means. Unfortunately the only opportunity we have had to try the method occurred at the very commencement of our experiments with living sutures, and our operation was very imperfectly performed. Recurrence of the dislocation was prompt. We

are still of the opinion, however, that the method might be useful in cases which are definitely the result of relaxation of the capsule of the joint.

3. UNUNITED FRACTURE OF THE PATELLA.

The success of the operations on the ligamentum patellæ already referred to led us to apply a similar method to cases of ununited fracture of the patella in which the bones could not be brought together, or in which the fracture had occurred so close to the upper or lower border of the bone that it seemed unlikely that an operation designed solely to induce union in the fracture would provide sufficient strength to withstand the normal strain. In the former the fragments were drawn as closely together as they would come, and were held in this position by a heavy loop of fascia lata passed through drill holes. The ends of the loop were freed of arcolar tissue and woven through one another and sutured with catgut. By this means the continuity of the quadriceps was established and a considerable portion of the normal extensor power restored.

In the ununited fractures close to the upper or lower border of the patella, the drill holes were made in the large fragment only, and a loop of fascia was drawn through the quadriceps tendon or the ligamentum patellæ through a transverse tunnel made with a narrow knife. The presence of the small flake of bone on the end of the tendon prevented the loop from cutting out. One case will illustrate the effectiveness of this operation. The patient was a tall young man, weighing 250 lb., who had fractured his patella some months previously through the lower tip of the bone, with wide separation of the fragments. He had been treated by placing the limb on a posterior splint, but no union had taken place. He was seriously handicapped by inability to extend the knee. The operation consisted of bringing the freshened surfaces of the fragments together and inserting a loop of fascia lata, one inch in width, through two vertical holes in the upper fragment and transversely through the ligamentum patellæ just below the lower fragment. The transverse rent in the lateral expansion of the quadriceps tendon and the capsule of the knee was closed with a living suture of fascia threaded on a needle. A complete cure resulted. (*Fig. 230.*)

4. INFANTILE PARALYSIS OF THE SHOULDER IN SMALL CHILDREN.

In infantile paralysis involving the shoulder girdle, but sparing the trapezius, no better operation has been devised than arthrodesis of the shoulder-joint. In small children, however, it is impossible to ankylose the joint owing to the relatively small amount of bone in the articulating surfaces. In several such children we have materially improved their condition by weaving the acromion process to the greater tuberosity of the humerus with strips of fascia lata. These strips were passed through holes in the two bones and drawn sufficiently tight to hold the humerus in moderate abduction. When firm healing had occurred the patients were able to abduct and raise the humerus by means of the trapezius. The method is limited in its application, however, as there is no great reason why these patients should not wait till the bones entering into the shoulder-joint have developed sufficiently to allow a successful arthrodesis.

5. FACIAL DEFORMITIES.

In the field of plastic surgery, particularly in that of the face, the principle of living sutures may prove of value. It has been used with excellent results by our *confrère*, Dr. W. W. Wright, in the treatment of congenital ptosis of the eyelids. In this

operation two strands of fascia lata about one-sixteenth of an inch wide are threaded on curved needles and tied in as

already described. A needle is attached to each end of the suture. A horn plate is placed beneath the eyelid and two small puncture wounds, as shown in *Fig. 231*, are made through the skin at A and C with a sharp-pointed tenotome about 6 mm. above the margin of the lid.

A transverse incision B D, 1 cm. long, is made just above the brow.

One needle is now entered at A and carried upward subcutaneously to

emerge at the nasal extremity of the incision B D. The other needle is then entered at A, passed under the skin, brought out at C, re-entered through the same hole, and brought out above at the temporal end of the incision B D. The second suture is then inserted in a similar manner in the outer half of the lid. The ends of the sutures are now drawn tightly enough to

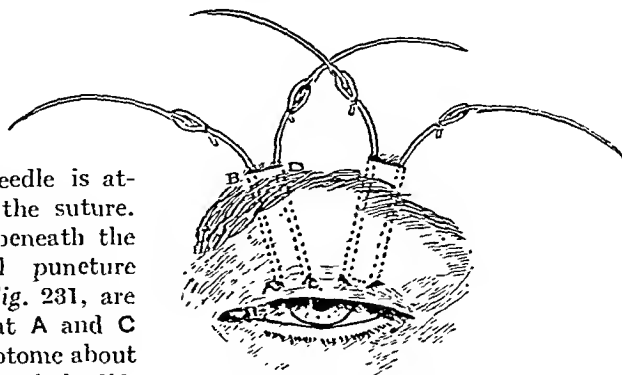


FIG. 231.—Diagram of operation for congenital ptosis of eyelid in which the lid is permanently suspended from the occipitofrontalis with narrow sutures of fascia lata.



FIG. 232.—Photographs of patient on whom the operation for congenital ptosis of the left eyelid had been performed 3½ years previously.

raise the lid to the desired height, and are then tied in a knot which, after transfixion with fine catgut, is dropped back into the transverse incision and buried under the skin.

The accompanying photographs illustrate the result of this operation after the lapse of $3\frac{1}{2}$ years (*Fig. 232*). No change in the suspension of the eyelid has occurred during that time, and the boy has excellent control of it through the action of the occipito-frontalis. Twelve patients have been operated upon by this method at the Hospital for Sick Children, and all with satisfactory results.

6. VISCEROPTOSIS.

The uncertainty which attends operations for the fixation of viscera may possibly be removed by the substitution of strips of fascia for catgut. Our clinical experience with the method has not been great, but as far as it has gone it has been encouraging. Two cases of floating kidney which had been suffering from crises of abdominal pain were treated by sewing the kidney to the abdominal wall with sutures of fascia lata. In each case the symptoms have been relieved and the kidneys have remained in place. The first patient was operated upon three years ago, and the kidney was fixed by the simple weaving of a fascial suture through the capsule and into the lumbar aponeurosis. In the second case, operated on eighteen months ago, two separate sutures were used, one of which was passed through the upper pole of the kidney and around the last rib, and the other inserted as a large mattress stitch under the capsule and fastened into the abdominal aponeurosis. When the occasion arises again we shall use sutures obtained from the fascia of the back and so avoid the necessity for an incision in the thigh.

7. HERNIA.

A thoughtful analysis of the results of the operative treatment of hernia in adults will convince the most sanguine that there is much room for improvement. The percentage of recurrences varies greatly with the experience and skill of the operator, but, even in the hands of the most skilful, recurrences after the closure of large ventral hernias, direct inguinal hernias, and long-standing oblique inguinal hernias are very frequent.

It was in the treatment of these conditions that the transplantation of patches of fascia lata first came into prominence, and for a time it seemed that the difficulties in the way of a cure had been successfully solved. Before long, however, recurrences again began to appear, and ultimately became so frequent that nowadays the method has very few advocates. In explanation of these failures one often hears it said that the transplant has been absorbed. Our researches, however, have led us to the opinion that in the majority of instances this explanation is incorrect, and that the blame for the recurrence of the hernia must be laid to the character of the healing between the transplant and the surrounding tissues. Our experiments on animals resembled very closely the usual method of filling a defect in the abdominal wall with a patch-transplant, or of re-enforcing the line of suture after closure of the opening. The same care in overlapping the edges of the transplant and the surrounding tissues was observed. But the experiments indicated that, although the patch

of fascia continued to live almost unchanged, it healed to the edges of the defect by the flimsiest kind of tissue, and if the line of contact were under strain the edges almost invariably drew apart. This separation of the edges is even more likely to occur in operations on hernia, as operators rarely take the precaution to remove the areolar membranes from the surface of the transplant and the edges of the defect. The adhesion, therefore, can have only the strength of these areolar membranes, and can be of no importance whatever in preventing the separation of the hernial ring.

If one is tempted to use a patch-transplant to assist in the closure of a ventral hernia, one should observe the precaution of scarifying the surfaces of the transplant and of the surrounding tissues which are placed in contact, in order that firm adhesion may take place. In spite of such precautions, however, the surgeon must place his whole trust in the character of the healing which occurs, the strength of which is very uncertain. The light scar-tissue which develops between overlapped aponeurotic surfaces is not equal to the strain which must be resisted in large ventral hernias. There is no probability, therefore, that the use of patches of fascia lata, sewn in with absorbable sutures, will ever be revived again.

Ventral Hernia.—Ventral hernia is an ideal condition for closure with living sutures. By their use the uncertainty which attends healing by scar-tissue is totally eliminated and the whole responsibility for a cure placed upon the sutures themselves. There is practically no limit to the number of sutures that may be inserted, so that it becomes simply a matter of the judgement of the surgeon as to how many layers of sutures are necessary to restore the abdominal wall to its normal strength. The chief precautions which must be observed are to see that the sutures are woven securely into the tissues surrounding the opening, and that these tissues, wherever possible, include aponeurosis. It is preferable to make no preliminary dissection of the edges of the hernial ring into their various layers, as the grip of the sutures is most secure when they are undisturbed. If the edges of the ring can be drawn together without too great tension, so much the better; but if they cannot, the gap which is left may be closed by weaving the sutures across the opening as in the darning of a sock.

From our experience with living sutures a few points in technique have been evolved which are useful. Much time can be saved by having a second operator to secure and prepare the sutures. A few minutes before they are required he makes a long incision on the lateral aspect of the thigh and exposes the fascia lata. The fat and areolar tissues are carefully removed with the blade of a scalpel over the whole area from which the sutures are to be taken. A small longitudinal incision is then made through the fascia, and with a pair of blunt-pointed scissors it is ripped to the required length. This will vary from nine to twelve inches according to the length of the thigh. A second incision in the fascia is made a quarter of an inch lateral to the first, and one end of the suture so prepared is cut free and trimmed to a point. This end of the suture is passed through the eye of a large curved needle, and tied securely after transfixion with fine silk. The needles are very thick, and have an eye which is large enough to allow the strip of fascia to enter easily. The terminal end of the suture is then cut free, and a fine linen ligature is tied

around it to prevent splitting. The suture is now lifted from its bed and is ready for use. In taking the first stitch the needle is passed through a tough portion of the edge of the gap to be closed and then through the terminal end of the suture. In this way a slip-knot is produced which forms an excellent anchor. The suture is woven strongly into the edges with as many bites as

seem necessary, and passed backwards and forwards across the opening until its whole length is used up. Owing to the slippery character of the fascia it will be found useful to anchor the sutures at every second or third stitch by some form of knot. We usually combine a single loop-knot with transfixion. When the first suture has been used up a second may be attached to it in the same way as pieces of tennis gut are fastened together, and the sewing continued. In this way one suture after another may be inserted until the opening is completely closed. The suture is finally ended by splitting its terminal portion into two strands which are tied together about the suture in a triple knot. This knot should be made secure by transfixing it with a catgut ligature which will hold its loops in contact until they become firmly healed together. (Fig. 233.)

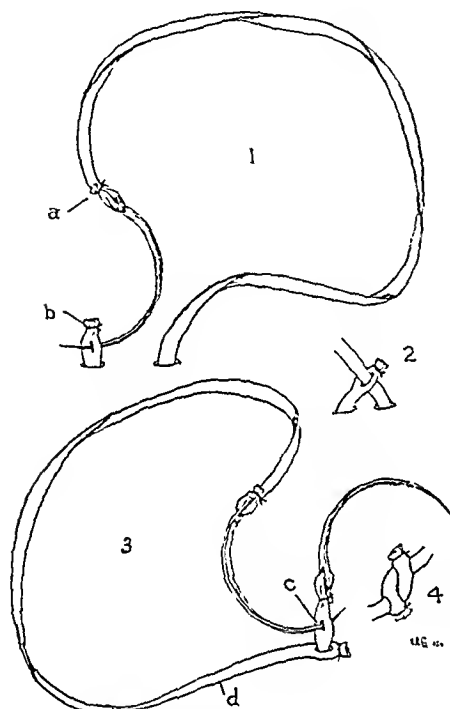


FIG. 233.—Diagrams illustrating points in the technique of using living sutures of fascia.

1, The strip of fascia lata has been tied into a large-eyed needle with fine silk (a), and a similar ligature has been tied around the tail of the suture at b. The needle has been passed through some strong aponeurotic tissue and then through the tail of the suture to form a slip-knot. 2, The slip-knot drawn taut. 3, Method of joining one suture to another. The suture (c) has been used up. The needle of suture c is passed through the tail of suture d, and the needle of suture d is then passed through suture c. The needle of suture c is cut off, and suture d is drawn taut. 4, The jointing of the two sutures completed.

from the thigh, has there been any complaint of symptoms or any evidence of disability resulting therefrom.

The details of the operation for ventral hernia are simple. The sac is dissected free of the edges of the ring, and removed or pushed back without opening it, as seems best at the time. The peritoneum is separated from the abdominal wall in the immediate neighbourhood of the opening in order

The wound in the thigh has never given us any concern. Where not more than four sutures have been removed, the opening in the fascia can be readily closed with catgut, and there does not appear to be sufficient strain upon it in the ordinary movements of the thigh to cause it to open again. In several instances, however, so much fascia was used that the opening could not be closed, and in these cases no attempt at closure was made. In not a single patient, of the two hundred or more in whom strips of fascia have been removed

that the sutures may be inserted without puncturing it. As already stated, the edges of the hernial ring are not separated into the various layers of aponeurosis and muscle, as it has been found that by so doing the strength of the grip of the sutures is lessened. After securely anchoring the suture in some aponeurotic structure the opening in the abdominal wall is closed by a through-and-through running stitch. Care is taken that each loop of the suture passes through strong aponeurotic tissue, well back from the edges of the opening, so that all possibility of cutting out is avoided. So secure is

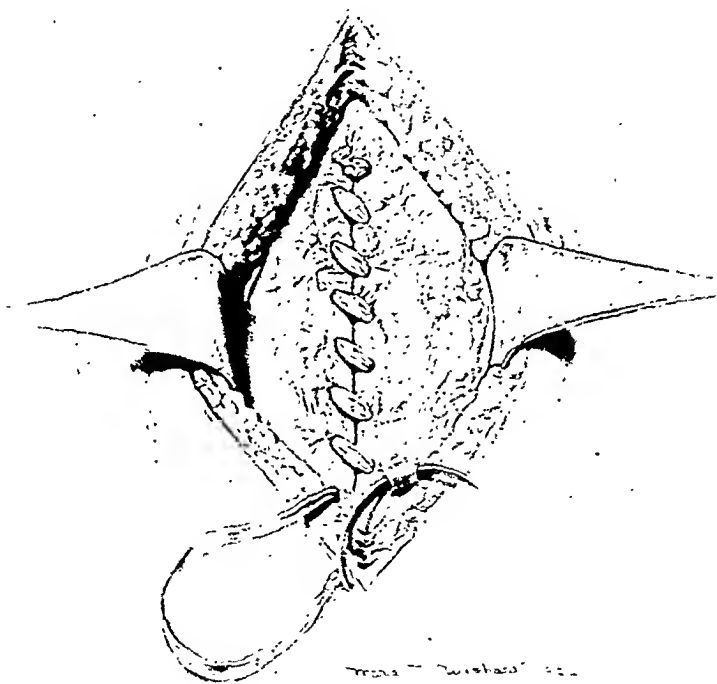


FIG. 234.—Drawing of the repair of ventral hernia with sutures of fascia lata. Insertion of the first row of sutures which brings the edges of the defect together or as nearly together as they will come without great tension.

the closure when performed in this way that in most instances a single row of sutures is sufficient, but when the opening is larger, or the anticipated strain severe, it is well to support the first row of sutures by a second. This is inserted somewhat as in the lacing of a boot. By means of it the strain is distributed widely over the abdominal wall, and the tension on the former defect correspondingly reduced (Figs. 234, 235).

In some of our cases the opening in the abdominal wall has been so large that it was impossible to draw the edges together by any form of suture. In

other cases it was possible to draw them together only at the risk of so increasing the intra-abdominal pressure as to endanger the patient's life. In these patients the edges of the opening were simply drawn as closely together as seemed safe, and the space left was completely filled with a meshwork of sutures. The strips of fascia were so interwoven with one another that no chinks were left through which a hernia could occur. When the healing

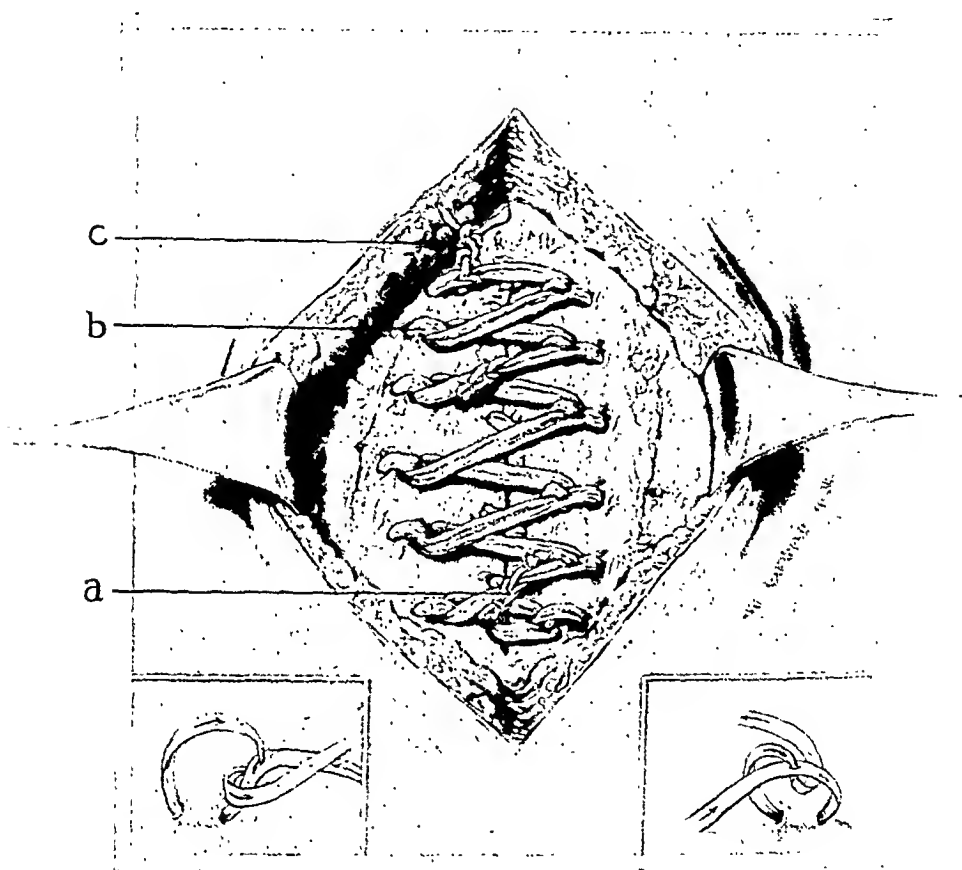


FIG. 235.—Drawing of the repair of ventral hernia. Insertion of second row of sutures. The needle takes deep bites of the aponeurosis at some distance back from the edges of the opening.

a, A join between two sutures; *b*, Lock-stitch inserted to prevent slipping; *c*, Triple knot which terminates the suture. It is transixed with a ligature of fine silk or catgut.

The inserts in the lower corners show methods of making the lock-stitch.

process is complete the abdominal defect is filled with an aponeurotic structure which is comparable with the linea alba.

During the past five years the sutures of fascia lata have been used on many occasions in closing ventral hernias. Most of the cases had been operated upon previously by other methods, and in all the possibility of a permanent closure was doubtful. In some it seemed certain that operative treatment would be futile. So far all the operations have been successful.

In several in which it was impossible to close the gap completely the strands of fascia and the knots can still be felt distinctly through the skin.

Inguinal Hernia.—Our attention was drawn to the question of recurrence of inguinal hernia by the large numbers of soldiers who have returned to our military hospitals for treatment of hernias which had already been operated upon once and sometimes several times previously. Many of these patients have come under our direct care, and we have taken the opportunity to study the cause of the recurrence and to attempt to find a remedy for it.

The histories of these patients indicated that some of the hernias had been present from childhood and had been operated upon just previous to enlistment, and that some had developed during service and been treated by operations in military hospitals. In the majority of cases the patients had been kept in bed for three weeks after operation, and had been brought up to class A category by several months of graduated physical training. Little criticism could be offered of the after-treatment.

Our findings at operation showed that a few which originally had been oblique hernias had recurred into the cord. In all probability the sac, in these cases, had never been completely removed. The majority, however, had recurred as direct hernias, irrespective of what the condition had been originally. That direct hernias should recur is not at all surprising, as the records of any hospitals in which this subject has been investigated show that recurrence takes place in from 40 to 50 per cent of the cases, but that hernias which were originally oblique should recur as direct hernias appealed to us as wanting explanation. Unfortunately it is impossible to state definitely from an examination of these patients on the operating table just what was the cause of the recurrence. In most cases the external ring was very large, but whether this was the cause or the result of the recurrence it is impossible to say. In many of the men the hernia had been present for a long time before the original operation, and it may be that the posterior wall of the canal had become so weakened by the dragging of the internal ring towards the external that it was unable to resist the increased abdominal pressure coincident with war-time activities. On the other hand, it may be that the weakening of the abdominal wall has resulted from the original operation in which the fascia transversalis may have been injured or the abdominal muscles destroyed by tight sutures. Whatever the cause of the recurrence, the indications are that in operations for inguinal hernia in adults definite precautions must be taken to leave the abdominal wall medial to the internal ring as strong as it normally should be, and if there is any possibility of the posterior wall of the canal being weaker than normal, it must be supported by some form of plastic operation which is more certain than the ordinary methods of suture.

The defects in these methods of suture were very evident in the cases operated upon. In some the internal oblique muscle had been sutured to Poupart's ligament in front of the cord. In the majority, however, the internal oblique and the conjoined tendon had been sewn to Poupart's ligament behind the cord in an attempt to restore the obliquity of the canal. What may be the relative merits of these two methods of suture it is impossible to say, although theoretically, presuming that the structures which are sewn together stay together after the sutures are absorbed, the latter would seem to be the

more rational. Our findings indicate, however, that it is very problematical whether the structures which are sewn to Poupart's ligament really do stay in this position for any length of time. In every recurred hernia operated upon the internal oblique muscle had separated from Poupart's ligament throughout its inner half, and in some there was no evidence whatever that it had been sewn to the ligament. In not one instance, despite the fact that the records showed that the conjoined tendon and the sheath of the rectus had been sewn to Poupart's ligament with kangaroo tendon or catgut, did we find these structures together at the time of the second operation.

These findings have produced a doubt as to whether the sewing of the muscles and conjoined tendon to Poupart's ligament with ordinary sutures is ever a factor in preventing recurrence of the hernia. Certainly the experiments in which plication of the fascia of the rabbits' backs was performed would indicate that the adhesions of such structures is extremely slight. To investigate the subject further a few experiments were performed in which muscles were drawn out of their normal positions and sewn side-to-side with other muscles and with tendons and aponeurosis. In a very short time after the absorption of the sutures the muscle had returned to its former position, leaving no indication that an operation had been done. If, before inserting the sutures, all areolar membranes were removed from the surfaces which were placed in contact, and particularly if these surfaces were scraped and scarified, the amount of adhesion was greater; but if the normal action of the muscle tended to produce definite strain on the line of suture, the scar-tissue soon became stretched and the intention of the operation defeated. These results demonstrate the folly of dragging structures such as the abdominal aponeurosis, the conjoined tendon, and the sheath of the rectus out of their normal positions to suture them to Poupart's ligament in the hope of permanently strengthening the abdominal wall.

Direct Inguinal Hernia.—In the case of direct inguinal hernia the defect in the ordinary Bassini operation has frequently been recognized, and many attempts have been made to improve on this operation by filling the defect in the abdominal wall with muscular or aponeurotic structures which might be able to withstand the strain. Thus, the transplantation of a portion of the rectus muscle to Poupart's ligament, the turning down of flaps of the rectus sheath, and the transplantation of patches of fascia lata have all had their advocates. These operations all have the defect, however, that they depend for their success on the healing together of fibrous or muscular structures, a factor which unfortunately cannot be depended upon. None of them, therefore, has ever become recognized as the established method of procedure.

The structures about the inguinal canal are peculiarly suitable for the use of living sutures. No dependence can be placed on a muscle such as the internal oblique, but in the immediate neighbourhood are the abdominal aponeurosis, the conjoined tendon, the sheath of the rectus, and Poupart's ligament, all strong fibrous structures which will give firm anchorage for the suture. With a sufficient number of strips of fascia lata, therefore, the weak spot in the abdominal wall can be filled up completely without any disturbance of the normal anatomical relations and without any dependence on the uncertain process of healing.

The operation for direct inguinal hernia presents no difficulties. The incision is made so as to allow perfect exposure of the spine of the pubes and the insertion of the conjoined tendon and the rectus sheath. After splitting the external oblique, the upper leaf is reflected until a good view is obtained of the white abdominal aponeurosis. The sac is dealt with in the usual manner, although occasionally we have done nothing with it more than to push it backward out of the way. The first suture of fascia lata, a quarter of an inch wide, is then anchored securely into the rectus sheath close to its attachment to the pubic bone. The needle is now passed behind the spermatic cord to pierce Poupart's ligament at its insertion into the pubic spine. If possible it should be made to pick up the periosteum to make the security of its fixation more certain. When the suture is drawn taut, the weakest spot in the abdominal wall, namely, that which lies behind the external abdominal ring, is filled with a tough aponeurotic tissue which effectively prevents any bulging through the ring. The sewing is continued in an outward direction, drawing the internal oblique muscle to the reflected portion of Poupart's ligament behind the cord, until the position of the internal ring is reached. Here the suture is locked and then carried to the outer side of the ring, where a supporting stitch is inserted. In this way the cord, at the point where it disappears through the abdominal wall, is surrounded by a fibrous ring which will effectively prevent the development of a hernia at this point. By locking each stitch at this stage the possibility of undue constriction of the cord is prevented. The sewing of the internal oblique muscle to Poupart's ligament in this manner is a detail of the operation which in our opinion is of very little value in preventing recurrence of the hernia. It is of value, however, in permanently covering the peritoneum with a thick layer of muscle which will prevent the protrusion of peritoneum through the chinks of the next layer of sutures, which is the important one in the prevention of recurrence. This layer commences as a continuation of the first, at the outer side of the internal ring. The needle takes a solid bite of the abdominal aponeurosis at its point of fusion with the external oblique and is then passed behind the cord to pick up Poupart's ligament. The suture is carried backward and forward across the space, with frequent lock-stitches, until the sheath of the rectus is reached, and this also is woven to Poupart's ligament until the whole space is filled with fascia down to the pubic spine. No attempt is made with the second row of sutures to drag the abdominal aponeurosis and the rectus sheath out of their normal positions. No greater tension is exerted on the sutures than is sufficient to make them lie flat. The whole idea of the operation is to fill the weak spot in the abdominal wall with what may be called a filigree of living aponeurosis, and to depend on the strength of this filigree and on its grip on the surrounding tissues for the cure of the hernia. What one does with the external oblique is of relatively little importance. Usually in direct hernia it is too weak to be of any value to the surgeon. In our earlier operations we closed it down to the external ring with a narrow strip of fascia, but in the last four years we have simply sewn it up with catgut. The time which is spent in preventing a hernia from getting out of the canal is much better spent in preventing it from getting into it. (*Figs. 236, 237.*)

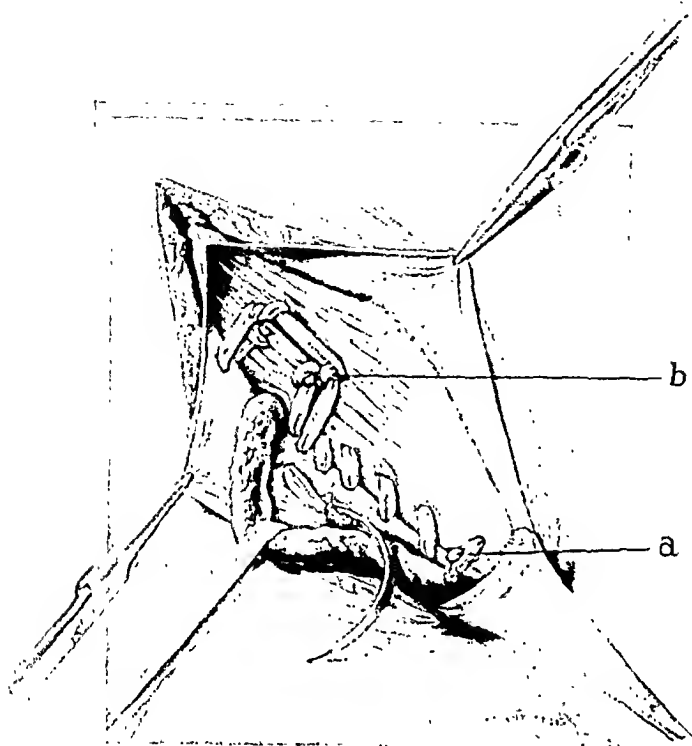


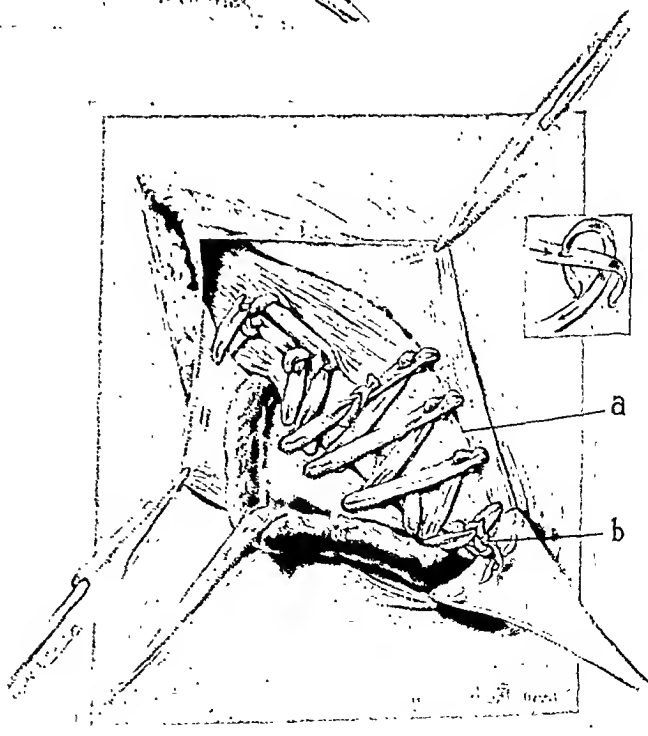
FIG. 236.—Drawing of the repair of an inguinal hernia with sutures of fascia lata. Insertion of the first row of sutures which brings the internal oblique and conjoint tendon into contact with Poupart's ligament, and reinforces the internal ring.

a, Slip-knot anchoring stitch ; *b*, Lock-stitch.

FIG. 237.—Drawing of the repair of an inguinal hernia. Insertion of second row of sutures between the abdominal aponeurosis and Poupart's ligament. These structures are not drawn together, but the interval between them is filled in with a filigree formed by the fascial suture.

a, The line of junction of the aponeuroses of the internal and external oblique muscles in the abdominal aponeurosis ; *b*, Termination of suture.

The insert shows the most useful form of lock-stitch.



Oblique Inguinal Hernia.—Oblique inguinal hernia rarely requires special attention to the closure of the abdominal wall. The cure of the hernia, particularly in children and young adults, depends on the complete removal of the sac. In these patients the posterior wall of the canal is normal, and if it is not damaged during the operation, should prevent the development of another hernia. Our researches on the healing of muscle to aponeurosis, and of aponeurosis to aponeurosis, and our observations on the patients in whom hernias have recurred, have led us to think that the internal oblique muscle and the conjoined tendon when sewn to Poupart's ligament rarely stay in the new position. The cures are accomplished in all probability quite irrespective of the attempt to close the supposed abdominal defect.

In many oblique hernias, however, the posterior wall of the canal is not normal. The constant passage of intestine and omentum into the sac gradually changes the narrow entrance of the tunica vaginalis into a wide funnel-shaped opening which materially stretches and weakens the fascia transversalis. The simple removal of the sac in these cases, therefore, leaves the posterior wall of the canal very weak and quite unfit to withstand unusual intra-abdominal pressure. This is true also, in even greater degree, in those cases in which the chronicity of the condition has resulted in the displacement of the internal abdominal ring to a position directly behind the external. These are the cases which call for some form of repair of the abdominal wall.

The operation for oblique hernia is identical with that already described for direct hernia. When it is completed the weak posterior wall of the canal is supported by a permanent meshwork of fascia lata which is sufficient, we believe, to withstand all variations of abdominal strain.

Femoral Hernia.—This form of hernia is a condition which should lend itself well to treatment with sutures of fascia. Unfortunately our experience with the method is limited to one case, so that we are not in a position to draw conclusions. This patient was a woman who had previously been operated upon for femoral hernia but had suffered a recurrence some months later. Our operation consisted of the removal of the sac through an inguinal incision, and the suturing of Poupart's ligament to Cowper's ligament with a suture of fascia lata. The suture was not drawn very tight, as it was not the intention to induce fusion of Poupart's ligament to the pubic bone, but rather to leave the former in its normal position and simply shut off the entrance of the crural canal with fascia. In this way the outer edge of Gimbernat's ligament, which bounds the inner margin of the femoral ring, was advanced in an outward direction by means of the fascia lata, to form the inner boundary of the compartment of the canal occupied by the vein. This operation has so far proved successful.

The treatment of femoral hernias by suture with catgut is by no means certain of success. In all probability the part of the operation which is the most important in accomplishing a cure, in those patients that are cured, is the removal of the sac. The insertion of a catgut suture from Poupart's ligament to the pectineal fascia through a femoral incision, or the suturing of Poupart's to Cowper's ligament through an inguinal incision, can have little effect in producing a permanent closure of the femoral ring. Certainly in the recurred cases which we have seen there has been very little evidence

to show that such suturing had been done. The substitution of fascia for catgut should remove this uncertainty and materially reduce the number of recurrences.

The results of the living suture operation in hernia have been very satisfactory. We now have records of over 100 hernias of all varieties which have been treated by this method over a period of five years, and, up to the present, there have been no recurrences. The majority of the patients had been operated upon previously by other methods, and many had been operated upon several times. The most gratifying results were obtained in the recurred direct hernias, which have hitherto presented a baffling surgical problem. We have no doubt that recurrences among these cases will occasionally appear, for defects in the anchoring of the sutures will sometimes be unavoidable; but if care is exercised in choosing only strong aponeurotic structures for the passage of the suture, and in anchoring it securely at its beginning and end, recurrences will undoubtedly be rare. Even suppuration is not an irreparable disaster, as three of our cases became mildly infected, but without extrusion of the suture or injurious effect on the ultimate result of the operation.

The method is recommended in the following conditions: (1) Direct inguinal hernia; (2) Oblique inguinal hernia in patients at or beyond middle age, particularly when the canal has lost its obliquity and when the abdomen is becoming pendulous; (3) All forms of recurred hernia; (4) All ventral hernias in which there is any doubt in the surgeon's mind as to the permanence of closure by the ordinary methods; (5) Ventral hernia in which closure can be obtained only with disquieting increase of intra-abdominal pressure—in these cases the edges of the hernial ring may be left apart and the space filled with a meshwork of fascial sutures.

CONCLUSIONS.

1. In the repair of certain anatomical defects the transplantation of fascia, aponeurosis, and tendon is a valuable surgical procedure.
2. Transplants of these tissues when given an adequate supply of lymph continue to live practically unchanged.
3. They heal to whatever structures they are placed in contact with by ordinary scar. The strength of this scar depends on the degree to which the surfaces which are in contact are denuded of areolar tissue and scarified, and on the area of these surfaces.
4. The employment of these tissues as transplants in the form of sutures removes the element of chance which attends healing by scar-tissue.

SUBMAXILLARY SALIVARY CALCULUS.

BY HAMILTON BAILEY, LONDON.

SALIVARY calculus, the Cinderella of the stones to which human secretory and excretory mechanisms are heir, owes its lowly position in the surgical estimation to the fact that it is never a direct cause of death. Sometimes, however, it is a source of much pain and very considerable inconvenience.

The populace of the East End of London (as revealed by the practice of the London Hospital) are rarely afflicted with stone in the parotid gland or its duct; nevertheless submaxillary salivary calculus is relatively frequent, the ratio being a little more than 50 to 1. Christopherson¹ observes that, in the Sudan, parotid are much commoner than submaxillary calculi.

This paper is founded upon 32 cases of stone in the submaxillary salivary apparatus which have, with the exception of one case, been collected from the out-patient department and the records of the in-patient department of the London Hospital.

Composition and Etiology of the Calculi.—Chemical analysis has shown that submaxillary stones and the 'tartar'¹¹ which collects upon the teeth are almost identical in composition. Both are mainly composed of phosphates and carbonates of calcium, together with small quantities of calcium fluoride and magnesium phosphate, and an occasional trace of sulphocyanide of potassium. These are combined in both instances with about 7 per cent of animal matter. Similarly the bacteriological⁵ examination reveals that both are swarming with micro-organisms.

It has been suggested that salivary calculus is due to a foreign body finding its way down the salivary duct. In support of this view a fish-bone has been seen in the centre of a calculus removed from Wharton's duct, and a feather³ causing obstruction has been picked out of Stenson's duct. Nevertheless these rare instances prove no more than the hair-pin, pieces of catheter, or other foreign body occasionally found within a stone of the bladder. Salivary calculus is an irreversible colloidal adsorption compound sharing with its more illustrious sisters, renal, biliary, pancreatic, and prostatic stones, a certain degree of indefiniteness as to precise etiology.

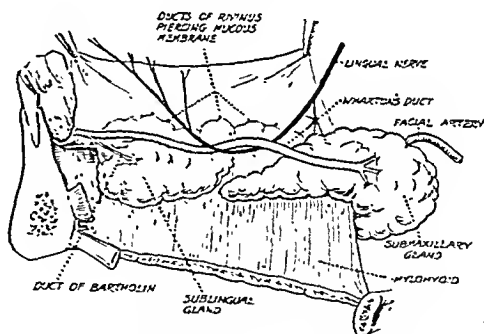


FIG. 238.—Dissection to show Wharton's duct and the structures in relation to it. (After Allen Thompson.)

Some Points in the Surgical Anatomy and Physiology of the Submaxillary Gland.—The submaxillary gland, riding astride the posterior free border of the mylohyoid, is divided into two portions: a cervical which occupies the submaxillary triangle of the neck, and a buccal which lies beneath the mucosa of the floor of the mouth. The cervical portion constitutes more than two-thirds of the total gland.

The relationships of the buccal lobe are shown in *Fig. 238*. Wharton's duct, traced backwards, will be seen to divide at the hilum into three primary divisions. These divide and subdivide to drain the 1500 lobules⁴ which constitute the parenchyma. A section through the ampulla of Wharton's duct is shown in *Fig. 240*, and *Fig. 241* is a similar section midway down the same

duct. A notable feature in the structure of the duct is the complete absence of musculature. One may therefore surmise that the passage of a stone along the duct, or, indeed, the normal ejection of saliva, must be accomplished by the pressure of the secreted saliva within the gland, aided perhaps by contraction of the muscles which constitute the floor of the mouth. This pressure is considerable. Leonard Hill⁷ has demonstrated that, if a manometer is tied into Wharton's duct, the pressure registered when the gland is in full activity may be greater than the arterial blood-pressure.

Clinical Features.—

Sex.—Males were nearly three times more commonly affected.

Age.—The age varied between 16 and 65.

Calculi may be present in the submaxillary gland and produce no symptoms. In this respect they may be compared with 'silent' renal and biliary stones. *Fig. 239* shows calculi found accidentally in a radiographic examination. There were no symptoms referable to the stones, and there were no signs when the submaxillary glands were palpated.

Spasmodic Pain ('coliques salivaires' of the French authors) typically occurs at the commencement of a meal. In more than 40 per cent of the cases in which pain was a feature the patient stated that it occurred before or (more often) during mastication. This pain is often severe, and it is described by the patients as like toothache.

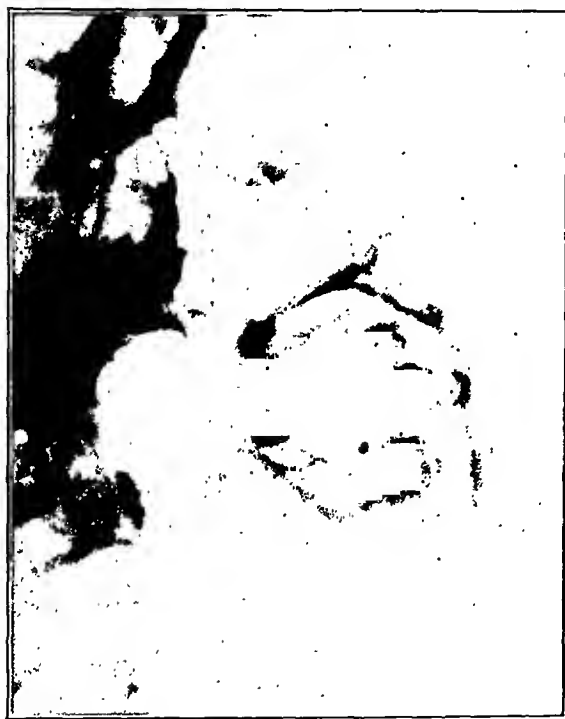


Fig. 239.—Stones in the submaxillary gland.

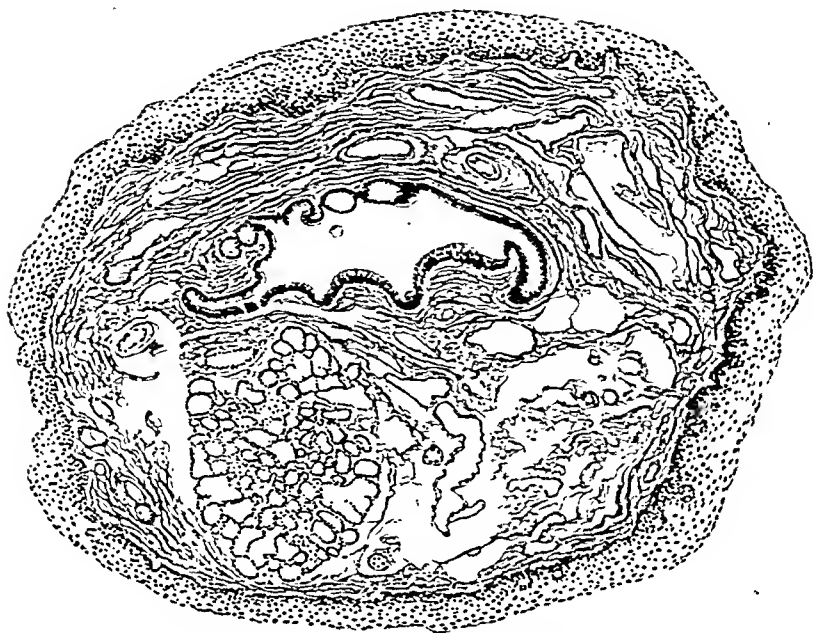


FIG. 240.—Transverse section through the ampulla of Wharton. (A prolongation of the sublingual gland into the papilla is shown.)

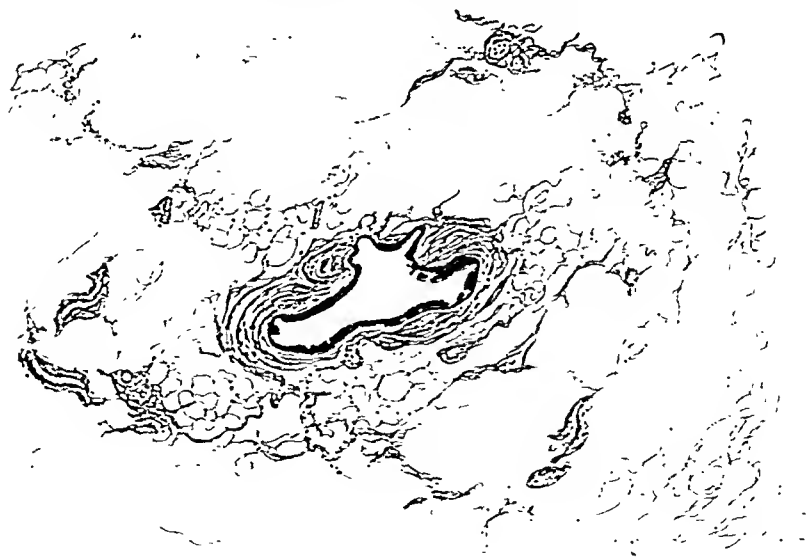


FIG. 241.—Transverse section through the middle of Wharton's duct. Sections stained with van Gieson and iron hæmatoxylin. There was no muscle demonstrable in the sections of Wharton's duct examined.

As a Cause of Lingual Neuralgia.—The intimate relationship of the lingual nerve to Wharton's duct explains the fact that the pain which accompanies the passage of a submaxillary stone may be referred to the tongue. In the case of a female of 22 under observation, this referred pain was described as "like a needle shooting down the side of the tongue". In this case the calculus was passed spontaneously.

A Swelling Beneath the Mandible is often a leading feature of the case. Variations in the size bearing a relationship to meals is pathognomonic of this condition.

Case 1.—A barber, age 61. For forty years he had noticed a swelling in the right submaxillary region, "most noticeable after eating gooseberries or anything tart". For four months the swelling has been larger and very painful. A large salivary calculus was removed from the posterior portion of Wharton's duct.



FIG. 242.—A method of palpating the submaxillary gland.

A Swelling in the Floor of the Mouth.—This is not commonly the chief complaint of the patient. It usually signifies that the stone is just behind the ampulla of Wharton's duct.

In general, it may be said that an aggravation of the symptoms owing to secondary infection is the most important factor in determining the patient to seek relief.

Physical Examination.—

The orifices of Wharton's ducts are inspected with the aid of a pocket torch, and the two sides compared. In a large number of cases of salivary calculus there is some aberration in the orifice of the affected side. In cases where secondary infection has supervened, the ampulla is inflamed, and sometimes pus

can be seen exuding from the duct. Very occasionally a stone impacted in the ampulla will be observed (*Fig. 243*).

A dry swab is inserted under the tongue, and a pinch of salt or, better, some lemon-juice is placed upon the dorsum. The patient is then asked to move the tongue about until he tastes the substance introduced, keeping the swab in place with his finger. He now opens his mouth and rotates the tongue upwards and backwards. The swab is removed, and the dried floor of the mouth again inspected in a strong light. Saliva can be seen flowing, occasionally being ejected, from Wharton's ducts. In cases of calculus impacted in Wharton's duct there will be little or no secretion from the affected side (*Fig. 243*).

SUBMAXILLARY CALCULI

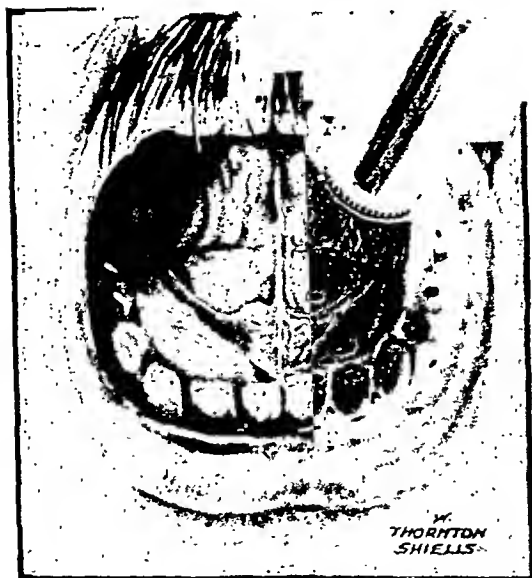
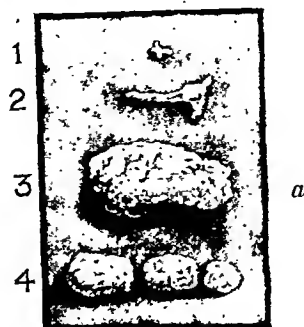


FIG. 243.—*a*, Specimens of calculi. 1. Calculus extracted from the ampulla of Wharton. 2. Calculus found in the hilum of the submaxillary gland after removal of the gland. Its shape suggests that a foreign body lies within. (*Specimen kindly lent by Sir Hugh Rigby.*) 3. Calculus removed from the posterior third of Wharton's duct. 4. Calculi extracted after slitting up Wharton's duct.

b. Stone impacted immediately behind the orifice of the right duct of Wharton. The patient is a man of 47. He is sucking a piece of gauze soaked in lime juice, which was placed upon the dorsum of the tongue. At the same time a dry swab was inserted under the tongue. This has just been removed, and a pocket torch illuminates the floor of the mouth. Saliva is flowing from the left Whartonian orifice and is beginning to collect in the sulcus to the left of the frenum linguae. The corresponding sulcus of the right side remains dry, for the duct is blocked by a tiny stone which can be seen shining through the mucosa.

As the submaxillary gland is composed of two portions, one above and one beneath the mylohyoid muscle, there can be but one efficient method of examining the whole gland, and that is by bimanual palpation (*Fig. 242*).

If, in a case of a doubtful enlargement in the submaxillary triangle, it is ascertained that there is a contiguous intrabuccal and cervical swelling, this is good evidence that that swelling is an enlarged submaxillary salivary gland.

A stone in the anterior two-thirds of Wharton's duct is easily palpated, and can readily be shown by an X-ray through the floor of the mouth; it is passed spontaneously in a fair percentage of cases, and in the remainder it can be extracted with comparative ease. A stone impacted in the posterior third of the duct is much more difficult to detect clinically, to show radiographically, and to treat effectively. Attention is therefore especially directed to palpation of the posterior third of Wharton's duct.

A Method of Palpating Wharton's Duct.—The patient's head is flexed and inclined slightly to the affected side in order to relax the musculature. The index finger is inserted into the mouth, the pulp of the finger being placed upon the internal alveolus. The finger is passed backwards, following the alveolus until the extreme posterior extremity is reached. The finger (now insinuated between the alveolus just behind the last molar tooth and the side of the posterior third of the tongue) is rotated through a right angle, so that the pulp of the finger is directed downwards. In conjunction with the fingers of the other hand beneath the jaw, the whole course of Wharton's duct is palpated from behind forward. In about one out of four patients this manœuvre brings on retching, but even in this event the valuable information required is elicited before any severe discomfort is experienced.

The sounding of Wharton's duct has a limited field of usefulness. It is sometimes of value in the type of case depicted above. Bowman's nasal-duct probe and a urethral guide are the instruments best adapted for the purpose.

Differential Diagnosis.—

1. *From Peridental Suppuration.*—Patients suffering from salivary calculus often attribute their pain to toothache. Selby¹⁰ records that nine cases of salivary calculus were referred to him as dental root abscesses for radiographic examination.

2. *From Cervical Lymphadenitis.*—The swelling in the submaxillary triangle (due to an enlarged cervical portion of the submaxillary salivary gland) is liable to be mistaken for submaxillary cervical lymphadenitis. The differential diagnosis between enlarged submaxillary lymphatic glands and the submaxillary salivary gland lies in bimanual palpation.

Case 2.—Female, age 38. Fifteen months previously she had an attack of 'neuralgia'. She visited a dentist and had two teeth extracted (right). Soon after a lump appeared under (right) lower jaw. For one year this has been treated by painting with iodine. Bimanual palpation showed the swelling to be the cervical portion of the submaxillary gland, the buccal portion being similarly enlarged. X-ray examination revealed a calculus in the extreme posterior portion of Wharton's duct.

3. *From a Neoplasm of the Submaxillary Gland.*—The type of case in which this differential diagnosis has to be made is the elderly individual with a mass of stones in the gland itself. The age of the patient, the stony hard

consistency of the gland, the irregularity of the contour, all help to strengthen the suspicion of malignancy.

The prostate gland may be taken as a parallel example. The differential diagnosis between prostatic calculi and carcinoma is sometimes impossible by clinical methods. Radiography, both in the case of the prostate and the submaxillary gland, has to a very large measure cleared up this difficulty.

In the same way light is often shed upon that even more perplexing problem, the differential diagnosis of submaxillary stones from a mixed tumour of the submaxillary gland.

When acute inflammation supervenes in a case of duct obstruction due to salivary calculus, the following conditions enter the clinical picture.

1. *Simulating Acute Primary Parenchymatous Glossitis.*—Stephen Mackenzie,⁹ in 1881, reported a case of a lad sent from Victoria Park Chest Hospital to the London Hospital with respiratory obstruction due to an acute enlargement of the tongue. The patient was given ice to suck, and provision was made for immediate tracheotomy should this measure prove necessary. The following morning the pain and swelling had considerably diminished, and the patient produced a salivary calculus which he had extracted from his mouth during the night.

W. H. Haskin⁶ records the case of a female, age 42, who sought relief for an enormous swelling of the tongue and enlarged glands of the neck, accompanied by fever. Three incisions were made into the dorsum of the tongue. Later, as the swelling did not abate, four more incisions were made. Finally, after the acute symptoms had subsided, a large calculus was found in Wharton's duct and removed therefrom.

2. *Simulating Ludwig's Angina.*—The following case is included in this series :—

Case 3.—Clerk, age 35, was admitted during September, 1921, into Liverpool Royal Infirmary. For two days he had had pain in the neck and difficulty in opening the mouth. On examination there was a brawny swelling of the neck, and pyrexia. Multiple incisions were made into the subcutis of the neck. Later, whilst the patient was convalescing, he spat out two fragments of calcareous material which proved to be a fractured submaxillary salivary calculus.

Three weeks after leaving hospital he was again troubled by a swelling in the neck. This time the symptoms were aggravated by the taking of food, and the swelling was confined to the right side beneath the mandible. He was again admitted, and the submaxillary salivary gland was extirpated.

Certain cases of peritonsillar abscess invade the submaxillary region and infiltrate the tissues beneath the angle of the jaw. Therefore, when dealing with the type of case under consideration, peritonsillar abscess should always be excluded.

Complications.—

Infection.—Calculi must produce stasis of the salivary flow. Consequently retrograde secondary infection is likely to, and almost invariably does, supervene. Acute spreading infection is a potential danger as long as there is a stone present in the salivary apparatus. In the six cases in this series where the gland was extirpated, histological examination showed chronic inflammation and fibrosis.

Carcinoma.—Carcinoma of the submaxillary gland is exceedingly rare. Up to the end of 1923 there were only twenty cases on record.² There is very little evidence to show that calculi predispose to this condition.

Stricture of Wharton's Duct.—This gives rise to symptoms identical with obturation by calculus. The stricture may follow suppuration around a calculus; probably, however, it is more frequently a sequela of extraction of the calculus from the duct, especially if the incision into the duct is not longitudinal.

Case 4.—Female, age 31. Twenty-four months ago a salivary calculus was removed through the mouth. Since then there had been intermittent attacks of salivary colic and swelling of the submaxillary gland.

The duct was catheterized, but this gave no relief. Later, the anterior portion of the duct was slit up, but the symptoms soon returned. The gland was therefore extirpated. No calculus was found.

Pathological report: Chronic inflammation of submaxillary gland.

Occasionally this stricture supervenes upon conditions other than calculus. Wharton's duct can usually be traced lying over the anterior aspect, but taking no part in the formation, of a ranula. This relationship renders Wharton's duct liable to injury during the excision of a ranula.

Case 5.—Male, age 20. Typical large unilateral ranula, treated by cutting away anterosuperior wall, evacuating contents, and scraping the remainder of the sac. A few weeks later "the submaxillary gland used to swell up to an enormous size, and the patient was temporarily unable to eat". The case has been lost sight of.

Radiology.—Submaxillary salivary calculi, being rich in mineral salts, usually cast a good X-ray shadow, but, as in other forms of calculi, the density

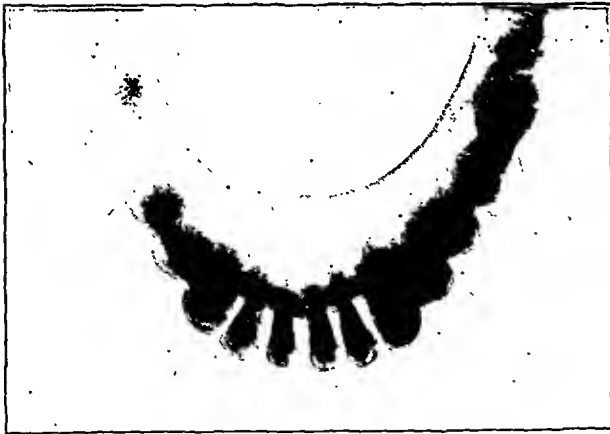


FIG. 244.—Stone in anterior third of Wharton's duct.
(M. H. Jupe.)

of the stone varies. Rays directed from beneath the chin on to a plate or a dental film within the mouth demonstrate a stone in the anterior two-thirds of the duct; but as a stone in this situation is usually found readily by clinical methods, the X-ray picture is often a matter of academic interest only. A stone in the posterior third of Wharton's duct, especially at its junction with the submaxillary gland, is, as has been shown, sometimes a difficult clinical

problem. It is in these cases, and in stones of the submaxillary gland itself, that an X-ray is almost indispensable. The lateral X-ray is the only reliable method of demonstrating a calculus in these situations. Even when a stone is demonstrable in the anterior two-thirds of the duct, a lateral X-ray to eliminate other calculi further back would prove a highly satisfactory measure.

Fig. 244 shows a stone in the anterior two-thirds of Wharton's duct; *Fig. 245* a lateral X-ray of a stone in the posterior third of Wharton's duct—'the difficult position'; *Fig. 239* multiple calculi in the submaxillary gland.

Treatment.—

1. *Expectant Treatment.*—In three cases under observation in this series, to the patient's surprise and relief a stone was passed spontaneously.

Expectant treatment consists in ordering a simple mouth-wash and examining the patient at intervals. Antispasmodics may be administered, but, observing that there is no musculature in the walls of Wharton's duct, only a general sedative action can be expected. Belladonna should be avoided, for it inhibits the secretion of the salivary glands—the motive power which drives the calculus onward.

Expectant treatment is especially indicated when there are no signs of suppuration in a case of a calculus not larger than an orange pip, situated in the anterior two-thirds of Wharton's duct, and X-ray examination has shown this calculus to be solitary.

2. *Slitting up Wharton's Duct.*—This can be accomplished under local anæsthesia. The indications are:

(a) Stone in the anterior two-thirds of the duct after expectant treatment has failed. (b) Stone in the anterior two-thirds of the duct with severe secondary infection. (c) 'Ball-valve' stones of the posterior third of the duct. An example of this was seen in a patient who had a stone in the posterior third of Wharton's duct, in whom expectant treatment failed. On the



FIG. 245.—Calculus in commencement of Wharton's duct.
(G. Vilandrè)

day elected for the removal of the stone it had apparently slipped back into the gland, for it was no longer palpable. In such a case, after the duct has been slit up, expectant treatment controlled by radiology is again instituted.

3. *Treatment of a Stone Impacted in the Posterior Third of Wharton's Duct.*—Occasionally a stone in this position is difficult to remove. Local anæsthesia is unsatisfactory in these cases. A general anæsthetic through a Junker should be administered. Doyen's mouth gag is placed in position on the non-affected side. Swabs, such as are used by dentists, inserted within the cheeks, are of value to minimize the collection of saliva. A suction apparatus would prove an ideal method of keeping a clear field. A stitch

through the anterolateral part of the tongue is a good retractor of this organ, which tends to occlude the view. A head light is an advantage.

It is first of all essential to 'fix' the stone. This may be accomplished by one of the following methods:—

a. Lane's tissue forceps are applied in such a way that the teeth close upon the tissues beneath and behind the stone within the duct.

b. A stitch is passed behind and beneath that part of the duct containing the calculus. A curved needle on a holder is used; but the needle should previously have been passed through a flame in order to remove the temper. If the needle breaks in this confined space it is difficult to extract the fragments. The needle which has had the temper removed has the additional advantage that it can be bent to such an angle as to suit the particular case.

c. The stone may be fixed by pressing it against the mandible (C. B. Lockwood⁸).

An incision is now made over the stone, keeping as nearly as possible to the long axis of the duct, in order to avoid subsequent stricture. The stone is best extracted with the aid of a scoop: forceps tend to crumble these soft calculi.

4. *Extirpation of the Submaxillary Salivary Gland.*—A satisfactory incision for this operation is that for ligature of the lingual artery. The indications are: (a) Multiple calculi within the gland giving rise to symptoms; (b) Long-standing cases of obstruction due to a Whartonian calculus, especially if the calculus is a recurrence; (c) Chronic inflammation of submaxillary gland which has persisted after removal of the stone which caused it; (d) Stricture of Wharton's duct after dilatation has failed.

The results of this operation are highly satisfactory. There is no instance in the records of the London Hospital of calculus recurring in the remaining salivary glands, and the patients are in no way inconvenienced by the loss of a submaxillary gland.

I beg to thank the members of the staff of the London Hospital for the many advantages I have been afforded. I am also greatly indebted to the sister in charge of surgical out-patients, without whose help the material for this paper could not have been collected.

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STRUCTURAL VARIATIONS IN THYROID METASTASES IN BONE, WITH REFERENCE TO BENIGN METASTATIC GOITRE.

BY F. GORDON BELL, EDINBURGH.

MUCH interest is attached to secondary thyroid tumours of bone, especially the variety which appears to present a normal or benign thyroid structure. The interest is still greater when the thyroid gland presents, or appears to present, no departure from the normal detectable on physical examination, or at most is the seat of a colloid or adenomatous change. Such cases have been interpreted in the past, chiefly through the influence of Cohnheim,¹ as examples of metastasis from a normal or benign thyroid—*benign metastatic goitre*; and if this interpretation be accepted, it allots to the thyroid a unique place in the range of surgical pathology, for no other structure has been credited with a like potentiality. It seems necessary, therefore, to weigh the evidence which may be taken to support Cohnheim's conception, and this may be considered under the three following heads:—

1. *Certain structural and functional features* of the thyroid gland require consideration as having a possible bearing on the problem. Ewing² points out in a general review of the principles of thyroid pathology that the gland possesses a remarkably abundant blood-supply capable of great variation, the circulation between the alveoli is of a sinusoidal character, and the glandular epithelium is brought into an unusually intimate relation to the vascular endothelium owing to the absence of a basement membrane. Great variations in function are closely related to these structural peculiarities, and in response to various stimuli the glandular cells may undergo enormous hyperplasia, as in toxic exophthalmic goitre, where the richness of the cell content may approach or surpass that of many frankly malignant tumours, and under certain conditions may return towards the normal, while under other circumstances the glandular epithelium may atrophy, and regenerate later. Consequently, it may be assumed that the thyroid cell proper possesses exceptional potentialities with regard to size, number, and functional activity, and in virtue of these attributes may possibly be rendered more mobile owing to its intimate relation to the endothelium of the sinusoidal blood-spaces through the absence of a basement membrane, and may thus pierce the slender barrier and enter the blood-stream. Once having entered the circulation, it is easy to suppose that such emboli, composed of normal or abnormal thyroid cells, may readily be deposited and grow in other parts, for the exceptional capacity of thyroid tissue to survive and to function in new surroundings is amply demonstrated by the success attending thyroid grafting. In this connection it will be interesting to observe whether grafts of admittedly normal thyroid tissue—placed, for example, in the head of the tibia, which is a popular site for

grafting at present—display any future tendency to erode the bone and to act in a malignant fashion as the so-called benign thyroid metastasis commonly does.



FIG. 246.—Fœtal adenoma. Reproduced to show the sinusoidal character of the circulation.

It is convenient here to refer to certain other histological and developmental features. The thyroid possesses a reserve supply of undeveloped glandular epithelium which, in response to a physiological call, may develop and assume adult characters. Some pathologists, especially Wölfler, have allotted great importance to these reserve islets, sometimes called Wölfler's rests, and hold them responsible for the development of thyroid adenomas, which in turn may give rise to metastasis, benign or malignant. Whatever be the rôle of these islets, it is an undoubted fact that secondary thyroid tumours in bone often display a structure closely resembling that of the fœtal or developing

thyroid or of the fœtal adenoma. The sinusoidal character of the circulation is often particularly observable in adenomata (Figs. 426, 247), and the endothelial lining of the blood-spaces may be so attenuated that the alveoli appear to be literally bathed in blood. This feature is exaggerated in the malignant adenoma, and accounts for the fact that the dissemination of thyroid carcinoma usually takes place by the blood-stream. It is conceivable that an imperfection of the sinusoidal endothelium, possibly aided by, or associated with, some slight trauma or strain, may allow the glandular cells in benign conditions of the thyroid to enter the circulation and give rise to a benign metastasis. Patel,³ in a paper entitled "Tumeurs benignes du Corps thyroïde donnant des Métastases", appears to attach importance to the peculiarities and richness of the capillary circulation, and notes the valve-less condition of the thyroid veins, especially the inferior set.



FIG. 247.—Colloid adenoma. Reproduced to show the tenuity of the sinusoidal endothelium. The darkly-staining spindle cells are seen here and there round the large alveolus, but are not detectable round the small alveoli, which are surrounded by blood-corpuscles.

2. *Errors in development* and the osseous inclusion of aberrant thyroid

tissue offer a plausible explanation for some benign tumours apparently unassociated with changes in the cervical thyroid. Such an explanation may hold in the region of the neck in regard to the mandible, sternum, clavicle, and possibly the cervical spine. Radley and Duggan⁴ invoke the aid of this theory in the case of a tumour of the clavicle, though a small tumour had been removed from the thyroid two years previously. Possibly Riedel's⁵ case, a tumour of the mandible recurring ten years after removal, might be similarly interpreted. 'Accessory thyroids', or misplaced islands of thyroid tissue, may be situated along the line of the thyroglossal tract, behind the sternum or clavicles, and towards the spine, and may conceivably be included in one or other of the bones mentioned, though there are certain anatomical objections. Such an origin can hardly be alleged in the case of the long bones, pelvis, ribs, skull, and lower part of the spine, and it seems necessary to assume that tumours in these situations must have arisen from detached thyroid cells carried by the circulation.

As bearing on this hypothesis, Joll's table mentioned below brings out the significant fact that the bones least likely to include aberrant thyroid tissue are most commonly the seat of metastasis, and of the 44 cases the skull and spine were involved 15 and 12 times respectively, as opposed to the clavicle and sternum 7 and 3 times.

3. *The chief evidence in favour of metastasis from a normal or benign thyroid* is derived from a series of cases reported by various observers where a thyroid tumour in bone has been associated with either a clinically normal thyroid or with some benign condition such as a colloid or adenomatous goitre. Joll⁶ has recently tabulated a comprehensive list of these two types, adding a case of his own and making some instructive comments.

The first group is admittedly small, barely reaching double figures, and must be accepted with great reserve in view of the fact that the cases have rarely been checked by an examination of the cervical thyroid that stands criticism. Ewing indicates his scepticism by pointing out that in none of these cases has the supposed normal thyroid been submitted to microscopical examination, and Albert Koehler⁷ takes a similar attitude.

The second group, in which a metastasis from a colloid or adenomatous goitre is postulated, is a much larger one. Many of the cases are open to criticism, and even Cohnheim's case, which is classical in that it gave the start to the conception of benign metastatic goitre, was not accepted by some of his contemporaries. In this case the thyroid was generally enlarged and was the seat of a gelatinous or colloid change, and the metastatic tumours in the spine, femur, and lungs were of the same type. Autopsy showed that a portion of the colloid growth had penetrated the wall of one of the inferior thyroid veins. Under such circumstances transplantation of thyroid tissue would readily occur, but it seems necessary to assume an abnormal growth activity on the part of the colloid goitre to enable it to penetrate the wall of the vein. Wöller⁸ expressed his opinion of these cases in words difficult to contravene: "When the glandular cells distributed by metastasis have given rise, in different situations, to tumours which not only grow but exert a destructive action on the bone, the primary tumour should be considered benign neither clinically nor anatomically, even if its malignancy cannot be established by microscopic examination."

It is the writer's object not to embark on any critical analysis of the recorded cases, but to emphasize the facts, which may appear obvious, that physical examination of the neck during life is entirely unreliable, and that superficial inspection of the thyroid at autopsy may readily fail to reveal minute changes within the gland (*see Fig. 252*); and further, to demonstrate by microphotographs that a secondary thyroid tumour of bone of unquestionable malignancy may display a structure, foetal or adult, hardly if at all distinguishable from that of a normal or benign gland. In such a cellular organ as the thyroid, where the cell content is subject to great variations, both in quality and quantity, within the range of the benign, the difficulty in determining the onset of an early malignant change is greatly enhanced, and the interpretation of the finer shades of malignancy is likely to remain a matter of personal opinion. The extreme view that it is only by complete or even serial section of the thyroid that minute foci of proliferation can be excluded is logically unassailable, but is beyond the range of the practical, and even if carried out would hardly yield any unanimity of opinion in so difficult a field.

THE MATERIAL.

The material available for discussion in this paper is admittedly too scanty for more than tentative conclusions, and is derived from three cases only, but of differing clinical types, which may be briefly summarized.

Case 1 had a frankly malignant goitre on first coming under observation, and in addition had a secondary deposit in a rib.

Case 2 presented the features of a simple enlargement of the thyroid for several years, with recent rapid growth of one lobe as the only suspicious feature, early malignant change being discovered on section and with the microscope. A secondary deposit appeared in the sternum two years after removal of the affected lobe, and, when the patient presented himself for further treatment after the lapse of another two years, the tumour in the manubrium had reached the size of an orange.

Case 3 presented no abnormality of the thyroid discovered during life, metastases manifesting themselves by pathological fracture of the right femur and great enlargement of the left ilium, the thyroid nature of these tumours only becoming evident at autopsy and on microscopic examination. This is the most interesting and important of the three cases, for it belongs to the type that has been the chief prop of the hypothesis that a normal or benign thyroid may give rise to metastasis. All three cases have direct practical bearings.

Case 3 illustrates the important principle that in dealing with an endosteal tumour the possible well-known secondary sources of origin such as the thyroid, breast, prostate, and kidney should be excluded before accepting the tumour as primarily osseous. This is a counsel of perfection, and in the case of a secondary thyroid deposit with no clinical change in the neck the exact nature of the bony tumour can only be determined by exploratory operation. The case is a striking illustration of the futility of depending on a physical examination of the neck to exclude a thyroid origin in the case of a doubtful tumour of bone, for the thyroid showed no abnormality, and only on microscopic examination was unequivocal evidence obtained that the thyroid had given origin to the tumours in the femur and ilium. The writer has recently

observed another case exemplifying the same point. This patient, an elderly man, was referred to the surgical wards for the removal for diagnostic purposes of a hard, enlarged gland in the left supraclavicular region. No primary source was detectable in the abdomen or neck, but microscopic examination showed the gland to be infiltrated with adenocarcinoma of unmistakably thyroid character. Even with this knowledge a further examination of the thyroid was entirely negative. Though an origin from aberrant thyroid tissue is possible in this case, it seems more reasonable to suppose that the parent source in the thyroid gland is still too small to be detectable by palpation.

Cases 1 and 2 illustrate the practical difficulties of this subject when a surgeon is confronted with the problem of dealing with a *single* thyroid metastasis in an accessible situation. How little guidance he obtains from the pathological confliction of ideas is best illustrated by quoting Jaeger,⁹ who lays down the following four sets of conditions relative to the thyroid and the metastasis: (1) Malignant thyroid—benign metastasis; (2) Benign thyroid—malignant metastasis; (3) Malignant thyroid—malignant metastasis; (4) Benign thyroid—benign metastasis.

If a surgical belief is based on the first set of conditions, the natural desire to do the best for the patient is strengthened by pathological support, and operation receives full justification if the primary tumour in the neck can be removed. The second set of conditions reduces the problem essentially to that of any primary malignant tumour of bone, with the addition that the benign (*sic*) source also requires attention. The third set renders the problem practically hopeless, and the fourth is the combination that all surgeons would prefer to meet.

Reducing the matter to the practical, and glossing over the lingering uncertainty as to the existence of other latent deposits not revealed by a searching radiographic examination, we may have to deal with a *single metastasis in an accessible situation*: (1) That develops after the removal of a thyroid tumour of low malignancy, of which *Case 2* is an example; (2) That is associated with a condition of the thyroid such as an adenomatous or colloid tumour which lends itself to removal with every prospect of success; (3) That is associated with a clinically normal thyroid where the exact nature of the bony tumour must remain uncertain till exploratory operation; and (4) That is associated with a definitely malignant goitre which can be removed or is treated by radium or other means. Under these sets of conditions, with the possible exception of the fourth, operation on the osseous tumour is certainly indicated, and in most cases, especially in view of the existing uncertainty as to the exact status of the metastasis *qua* malignancy, should be of a conservative nature.

CASE REPORTS.

Case 1.—Male, age 52. Complained of pain at the root of the neck, passing round the neck and up the sides of the head, of two months' duration, also pain over the ribs on the right side, of several weeks' duration. Examination showed a considerable enlargement of the thyroid, especially on the right side, and the gland was hard and adherent. Over the eighth rib, below the angle of the right scapula, there was a hard nodular swelling the size of a chestnut, evidently growing from the rib. The secondary deposit was excised along with several inches of rib, but the goitre was found inoperable on exploration, and the wound was closed with a view to future treatment by radium.

THE COSTAL METASTASIS.—On splitting the rib a small, solid, fleshy tumour was found expanding and replacing it.

Microscopical.—Generally it presents the features of an adenocarcinoma, destroying and replacing the bone. The cells are mostly spheroidal and are arranged irregularly, though in places they show an attempt to form acini with no lumen or duct-like spaces. There is no trace of colloid, and the general picture gives little suggestion of a thyroid origin, though presenting a superficial resemblance to foetal thyroid tissue, the solid clumps of columns of cell resembling those of a foetal adenoma (Fig. 248).



FIG. 248.—Case 1. Costal metastasis. Adenocarcinoma; shows typical structure, bearing a crude superficial resemblance to that of a foetal adenoma.

It is unfortunate that the primary tumour is not available for comparison with the secondary deposit, but the enlargement, hardness, and fixation left no doubt as to its malignant nature.

Case 2.—Male, age 47. Noticed slowly increasing enlargement of the neck for eight years, and applied for treatment owing to a rapid increase in growth on the left side during the last year. Examination showed a symmetrical enlargement of the thyroid, the left lobe displacing the larynx markedly to the right. The enlarged left lobe was resected, the patient

making a smooth recovery and returning to his occupation in Caithness. A diagnosis of early malignant change was made on microscopic examination. Two years later he noticed a swelling the size of a pigeon's egg in the upper end of the breast bone, which caused him so little discomfort that he delayed seeking further treatment for another two years, by which time the tumour in the manubrium had reached the size of an orange. As there was no return of the tumour in the neck and the sternal metastasis appeared to be the only one, it was decided to remove it.

OPERATION.—The muscular attachments to the sternum were divided, the 1st, 2nd, and 3rd costal cartilages cut through on both sides, the sternoclavicular joints disarticulated, and the sternum was sawn across between the 3rd and 4th ribs. At this stage the patient's condition became precarious, and the wound was packed with the object of completing the removal at a second stage; but he gradually sank, and died the same evening.

THE THYROID.—The resected left lobe was considerably enlarged, and on section showed marked pathological changes. Its medial part was occupied by a cyst the size of a Tangerine orange, while the solid peripheral part was sharply divided into an area composed of spongy tissue containing colloid, and a larger pale area containing scattered hæmorrhages and not unlike encephaloid cancer, giving the impression that a malignant change had been superimposed on a colloid cystic goitre.

Microscopical.—The spongy tissue shows the features of a simple colloid goitre. The pale, more or less solid area shows in parts marked proliferation and changes in the character of the glandular epithelium, though maintaining the characteristic thyroid structure to such an extent that a cursory examination of one area might fail to note the departure from the normal, or, in other words, might class it as a benign condition. Many of the alveoli are well formed, and are lined by cubical cells secreting colloid. The chief change appears to affect the inter-alveolar cell groups, and in some areas these form solid cellular patches enclosing here and there

small alveoli containing no colloid. The cells generally are larger than normal and stain poorly, and the nuclei are unusually large (*Fig. 249*).

It is noteworthy, as indicating the low grade of malignancy, that no recurrence took place in the remains of the thyroid in the four years between the first and second operations, and microscopical examination of the right lobe and isthmus after death showed merely the features of a simple colloid goitre.

THE STERNAL METASTASIS.—Generally it presents the picture of an adenocarcinoma destroying and replacing the bone, but shows considerable structural variations in different parts. The bulk of the tumour is made up of tissue presenting a general resemblance to the undeveloped thyroid, consisting of columns and clumps of cells suggesting an acinar arrangement without a lumen. In certain areas the cells assume an alveolar arrangement so definite as to render a thyroid origin unmistakable, though colloid is absent. The cells are either irregular or of the characteristic cubical shape. In the areas where active destruction and replacement of bone is going on, the type and arrangement of the cells are so irregular as to make the diagnosis of adenocarcinoma obvious.

To summarize, the metastasis exhibits variations in structure, ranging from undeveloped thyroid tissue to definite

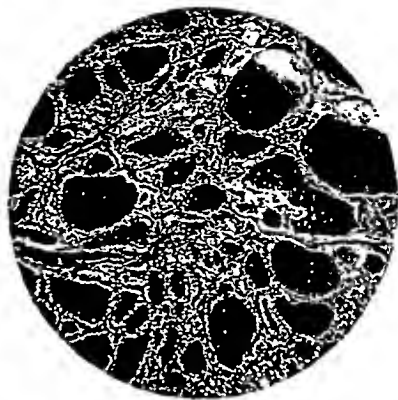


FIG. 249.—*Case 2.* Thyroid. Adenocarcinoma; but preserving a superficially benign appearance. The alveoli are still fairly uniform and contain colloid, but the cells for the most part differ from the normal and show a tendency to form solid patches.



FIG. 250.—*Case 2.* Sternal metastasis. Adenocarcinoma. The majority of the cells are arranged in solid groups, but commencing alveolar formation is evident.



FIG. 251.—*Case 2.* Sternal metastasis. High-power view showing general structure and the tendency to the formation of alveoli lined by cubical cells. Note broad resemblance to developing fetal adenoma.

adenocarcinoma, with here and there an attempt to reproduce the normal glandular features (*Figs. 250, 251*).

Case 3.—Female, age 48. Had complained of pain in the right hip-joint and difficulty in walking for several months. While confined to bed, the upper end of the right femur fractured spontaneously. A swelling became manifest in the groin, and pain was referred to the distribution of the femoral nerve, and was later succeeded by numbness. A skiagram revealed a fracture of the neck of the right femur, with marked rarefaction of the head and upward displacement of the trochanter. A tumour then developed in the left iliac region and gradually increased in size, œdema of the lower extremities became marked, and death took place two and a half years after the onset of the illness.

The post-mortem findings are described below. It is noteworthy that metastasis involved the bones alone, the lungs and lymph nodes escaping.

THE THYROID.—The gland at autopsy showed neither general nor local enlargement, and superficial examination revealed no departure from the normal: but on section the right lobe was found to contain three nodules about the size of a filbert. Two of these were hard and apparently fibrous, and the third resembled an ordinary adenoma.

The gland shows a more or less normal thyroid structure. The fibrous areas, however, display definite changes. They consist

Microscopically, the main part of the structure. The fibrous areas, however, chiefly of fibrous tissue, but enclose masses of glandular cells which differ markedly from those of a normal thyroid or of a typical encapsulated benign adenoma. The cells for the most part have lost their cubical shape and become spheroidal, and are arranged irregularly, but in some areas have a tendency to assume a tubular or alveolar disposition. The vascular network is unusually prominent, and the blood-spaces are large and thin-walled and of the character of sinusoids, the lining endothelial cells being in close relation to the glandular epithelium. Here and there the fibrous capsule contains small groups of compressed thyroid cells, and this may be interpreted either as an attempt to invade the capsule, or to represent outlying portions of thyroid tissue undergoing strangulation.

To summarize, the highly irregular arrangement and change in shape of the cell, the absence of colloid, and the embryonic character of the blood spaces strongly suggest a malignant adenoma (*Figs. 252, 253*).

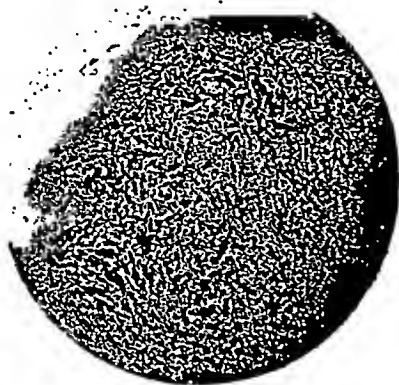


FIG. 252.—*Case 3.* Thyroid. Malignant adenoma. The entire proliferating nodule enclosed in fibrous tissue appears in a single low-power field. Several similar areas were present in other parts of the gland.



FIG. 253.—*Case 3.* Thyroid. High-power view of same, showing the sinusoids and the shape and arrangement of the thyroid cells.

THE METASTASES IN THE RIGHT FEMUR AND LEFT ILIUM.—

The femur: The head, neck, and both trochanters were completely destroyed and replaced by a large cavity filled with chocolate-coloured fluid, while the acetabulum was filled by a soft, friable, tumour-like material. On section of the femur, the tumour was found to have extended for some distance into the medullary cavity, where it displayed cystic areas.

The ilium: The greater part of the left ilium was completely destroyed by tumour formation, and the iliac fossa was occupied by a large mass which partially filled the pelvis and lay deep to the iliacus and psoas muscles. The left sacro-iliac was disorganized as the result of erosion by the tumour. On section, the mass was found to be cystic, and its appearance was highly suggestive of a cystic goitre.

To summarize, the destructive changes in both femur and ilium were on so marked a scale as to leave no doubt as to the highly malignant character of the invading deposits.

Microscopic Features.—

The femoral metastasis: The solid tissue replacing the upper end of the bone shows for the most part a structure resembling undeveloped and badly-formed fetal thyroid. The cells are arranged in small groups and columns. An acinar arrangement is easily distinguished, and in some areas the alveoli are well formed, are lined by cubical cells, and contain thin, badly-staining colloid—the thyroid character being unmistakable. Certain areas show a structure exactly reproducing that of the nodules in the thyroid gland already described, with the same tendency to invade the fibrous stroma.

The iliac metastasis: The tumour replacing the ilium shows a generally similar structure, but the formation of vesicles like those of the normal thyroid is in parts much more evident, and in small areas reproduces the features of an ordinary colloid goitre, giving the impression that when the fungating tumour is liberated from the mechanical restraint exercised by the rigid bony tissue, it tends to undergo colloid hypertrophy, while the tissue actively eroding the fibrous and osseous structures retains an undifferentiated type.

To summarize, the thyroid nature of the secondary deposits is everywhere evident, but displays striking variations. The fetal element predominates, and is hardly distinguishable from the normal developing thyroid; vesicular and colloid formation of the normal type is well marked; and in some areas the structure of the suspicious nodules in the cervical thyroid is exactly reproduced. Certain areas might well be regarded as displaying a benign structure, and illustrate the peculiar tendency of secondary thyroid deposits of a cancerous nature to revert to the normal: but no tumour displaying such obvious malignant tendencies as described above can seriously be regarded as benign (*Figs. 254, 255, 256, 257*).

The histological appearances of secondary thyroid deposits in bone, as portrayed in these three cases, display considerable variations, and this variability depends partly on the type of the parent tumour, partly on the duration of the metastasis, and partly on its local circumstances. One would suggest that in the early stages of a metastasis enclosed within bone the structure is likely to remain of an undifferentiated embryonic type. Later on, the striking tendency of the aberrant thyroid cells to arrange themselves in a more or less normal fashion asserts itself, and this tendency becomes all the more evident if mechanical restraint is removed, when the features of colloid hypertrophy may be superadded. In other words, the life history of a metastasis is likely to follow that of the developing cervical thyroid. Like it, the metastasis may function, as in the much-quoted case of von Eßelsberg,¹⁰ and similarly it may undergo colloid or cystic changes. Hence the examination of one part of an osseous deposit, or examination at one stage of its

development, may prove misleading, owing to the facility with which the thyroid cells assume structural variations.

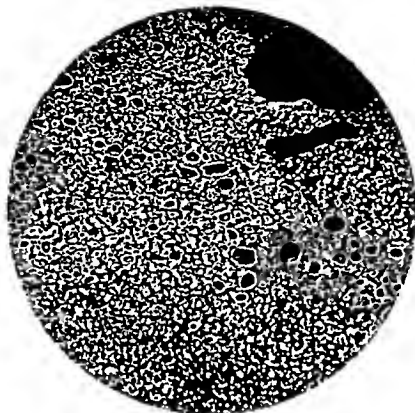


FIG. 254.—*Case 3.* Iliac metastasis. Shows the general structure typical of both this and the femoral metastasis. Solid groups of cells preponderate, but early alveolar formation of a regular type with colloid is well seen.



FIG. 255.—*Case 3.* Iliac metastasis. Shows various stages in development; solid groups of cells, small alveoli containing colloid, and dilated alveoli filled with darkly-staining colloid.



FIG. 256.—*Case 3.* Iliac metastasis. High-power view showing changes characteristic of a simple colloid goitre.



FIG. 257.—*Case 3.* Iliac metastasis. Another area showing well-marked alveoli of uniform size with commencing colloid formation.

Figs. 254 to 257 are reproduced to show the tendency of the metastases to revert to a normal or benign structure; but, as noted in the text, other areas exactly reproduce the structure of the nodules in the thyroid, and are regarded as certainly malignant.

The tendency displayed by secondary deposits of a carcinomatous nature to assume a structure resembling that of the normal thyroid—a feature first emphasized by Eberth and designated “the return towards the normal”

by French writers—requires most careful consideration before a secondary tumour can be accepted as having a normal or benign structure, and more stress should be laid upon the reaction produced by the deposit on the surrounding tissues and its capacity of eroding and destroying the bone than upon its histological characters.

SUMMARY.

The material is too scanty to permit of any formal 'conclusions', but the cases raise certain points which merit consideration :—

1. Metastatic tumours of bone of thyroid origin exhibit considerable histological variations.

2. An embryonic or foetal structure appears to form the basal type, and this may develop towards a normal thyroid structure with formation of colloid, or may assume frankly malignant characters. All these variations may be represented in the same tumour.

3. The fact that secondary tumours may exhibit a striking tendency to the formation of a structure practically indistinguishable from that of the normal or benign thyroid—"the return towards the normal"—probably provides an explanation for some of the so-called benign metastatic tumours.

4. This feature should be coupled with the fact that the proliferative changes in the thyroid indicative of malignancy may be so minute or even microscopical as to be readily missed in the absence of a thorough histological examination, and still more readily if reliance is placed on a clinical examination.

5. The sinusoidal character of the thyroid circulation, seen to great advantage in adenomata, may have a direct bearing on the origin of benign metastatic tumours.

6. The true criterion as to the benign or malignant nature of thyroid osseous deposits should be based on their destructive behaviour towards the surrounding bone rather than upon their histological characters.

Cases 1 and 2 were under the care of the late Professor Alexis Thomson in the Royal Infirmary, Edinburgh, and for the records of Case 3 I am greatly indebted to Dr. H. D. Wright, now of University College Hospital Medical School.

The microphotographs are the work of Mr. Pettigrew, Technical Assistant in the Department of Surgery, Edinburgh University.

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A NEW TECHNIQUE FOR ARTHRODESIS OF THE TARSAL JOINTS.*

By ALEXANDER MACLENNAN, GLASGOW.

THE problem of dealing with a paralytic foot resulting from infantile paralysis has been adequately solved by the performance of arthrodesis as recommended by Dunn. Unfortunately these cases are often complicated by deficiency in growth of the entire leg, and especially in that part of it below the knee. In such cases (*Fig. 258*) there is little benefit to be gained by stabilization of the tarsal joints. An arthrodesis of the ankle-joint added to that of the tarsal joints, with fixation of the foot in extreme extension (equinus position), is then advisable, as it adds the length of the foot to that of the leg.



FIG. 258.—To illustrate the condition suitable for this operation.

This operation as described by Mikulicz adequately fixes the foot, but it necessitates the resection of the tarsus, and thereby fails to gain the full possible lengthening of the leg. The operative technique about to be described has the advantage of producing the minimum of shortening of the foot, and, while it fixes the os calcis, also allows of some pressure being put on the heel, and so reduces that on the balls of the toes. This operation should not be performed until the patient has reached nine years of age, unless it be combined with a graft of bone extending from the tibia to the metatarsus.

In children under nine years much of the tarsal bone is cartilage; hence an arthrodesis is difficult to achieve in them. During the period of waiting, the foot is put up if necessary in successive plaster-of-Paris easings until a complete equinus position is obtained. Finally, a celluloid splint is moulded to a cast of the foot, and the child becomes accustomed to walk on the balls of the toes until the requisite age is reached.

The operation is carried out as follows: A tourniquet is applied to the thigh. A dorsal incision to the outer side of the long flexor of the great toe extends obliquely upwards from the space between the heads of the first and second metatarsal bones to the lower tibio-fibular joint. This incision reaches

* A communication made to the Association of Surgeons, Liverpool, May, 1924.

down to the bones, avoiding as much as possible the dorsal cutaneous nerves and the dorsalis pedis artery. The tendinous slip of the short extensor passing to the great toe crosses the incision; it is not worth while conserving it. The first and second metatarsal bones are separated by the knife from each other, a saw or osteotome is inserted, and the cuneiform, scaphoid, and astragalus are split vertically. In such feet the bones are usually much rarefied and soft. By the aid of retractors the split in the foot is forcibly widened, exposing all the joints (*Fig. 259*). The various joints are erased by the osteotome and sharp spoon. The only difficulty in the operation

will be found in rendering the obliteration of the astragalo-calcanear joint complete. If pieces of the very friable bone become detached during the operation,

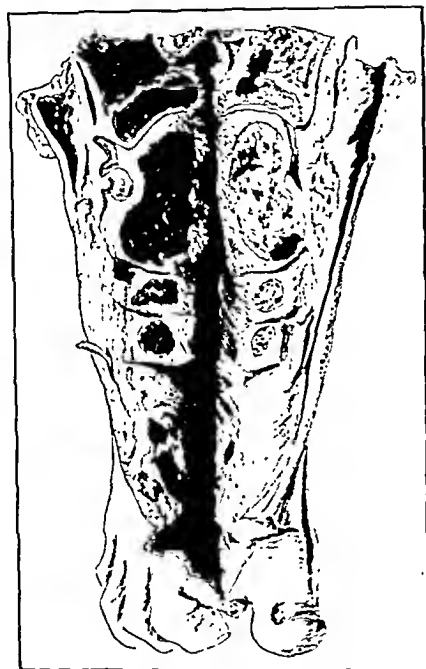


FIG. 259.—Specimen of split-foot from a child of 5 years, showing the free access to the tarsal joints.



FIG. 260.—Shows arthrosed foot in celluloid case.

they should be carefully preserved, and should be inserted into the wound before the incision is closed. Ligatures are not usually required, as the hæmorrhage is not serious. A few subcutaneous catgut sutures may be inserted, and the wound closed. The foot is put up with a lateral straight wooden splint, to be followed, when the sutures are removed in a fortnight's time, by a plaster-of-Paris case, which should be retained for eight weeks. After six weeks the child should be encouraged to walk, so as to stimulate the formation of the bone. A celluloid splint should then be fitted as shown in *Fig. 260*.

In none of the cases have there been any untoward symptoms. Little pain is complained of, and there has been practically no hæmorrhage. The external appearance of the foot is unaltered, and its length not appreciably

diminished. When fixation has been achieved, after a lapse of about six months, an artificial boot may be made so as to distribute the pressure between the projecting heel and the balls of the toes. The various illustrations will render further description of the procedure unnecessary (*Figs. 261, 262, 263*).

Altogether seven cases have been done on children between the ages of 10 and 12. In the first case the incision extended from the middle of the sole of the foot, between the first and second toes, up to the ankle-joint. The incision has now been curtailed to the dimensions referred to, as an incision



Figs. 261, 262.—To show foot after splitting operation.



FIG. 263.—Radiograph of foot shown in *Fig. 261* 6 months after operation.

into the sole of the foot was found to be unnecessary. The children walk without support of any kind other than a stiffened boot.

The only alternative to the operation would seem to me to be amputation.

CYSTINURIA WITH CALCULUS FORMATION.

BY HAROLD C. EDWARDS, LONDON.

CYSTIN calculus must be an extremely rare condition. Since Woollaston first discovered a cystin stone in the bladder of a child in 1810, only some 117 cases have been recorded. It is computed that $2\frac{1}{2}$ per cent of cystinurics develop stones, but this figure is probably high on account of the large number of unrecognized cases of cystinuria. The following case is of additional interest in that the passage of cystin crystals by the kidney is intermittent.

The patient is a man of 36, of medium height and build, giving a history of quinsy when three years old, and with nocturnal enuresis up to the age of seven. He first suffered symptoms of stone in 1901, when he had a severe attack of renal colic, and passed small stones per urethram. Two years afterwards he was operated upon for acute appendicitis with abscess. From 1903 to the present time he has had numerous attacks of renal colic, and has passed a large number of stones varying from minute dimensions to the size of a pea. The attacks have occurred at intervals of varying duration, sometimes of two to three months up to nine to twelve months. An attack may last anything from two hours to six weeks. In the long attacks, pain is subacute, with severe exacerbations.

He has always suffered from a weak digestion, and during the last twenty years—i.e., since the incidence of the renal complaint—he has been troubled with flatulence and a feeling of weight in the epigastrium. This is greatly exaggerated before an attack of renal colic, and forms an actual prodroma. Blepharitis, with much blepharospasm, and profuse watering of the eyes, are also prodromata. This condition reaches a climax during the renal attack, and slowly subsides.

He has often suffered from rheumatism affecting both knees. For some years he has suffered occasional attacks of acute inflammation, with much pain and swelling of the first joint of either big toe. This seems most liable to occur in the early days of spring, and simulates gouty arthritis. During the early part of such an attack, which lasts about three weeks, it is agony to put the foot to the ground, and even the contact of bedclothes is intolerable. A radiograph of the joints was negative.

He suffers from numbness of the arms on waking, frequent tremors, cramps at the backs of the knees, and a habit spasm of the arm when walking or driving. He is much addicted to talking in his sleep. Two years ago he suffered an attack of herpes in the scalp. He occasionally suffers from *aene vulgaris* on the back and shoulders.

In 1906, as a result of the first operation of litholapaxy, he developed an epileptiform attack, which recurred in two, three, or six months, and always happened during sleep. The interval lengthened until the attacks completely

disappeared some twelve years ago. Litholapaxy had been performed some eight times in all up to the time of admission.

EXTRACT FROM MEDICAL REPORT, JULY 11, 1922.

Examination of Faeces :—

Undigested muscle fibres	..	..	Nil
Undigested fats	..	..	Nil
Fatty acids and soaps	..	..	Nil
Undigested starch	..	..	+
Ova and parasites	..	..	Nil
Occult blood	..	..	Nil
Crystals	..	..	Nil
Organisms on culture	..	..	A high proportion of streptococci and diphtheroids.

Examination of Blood :—

Hæmoglobin	..	..	95 per cent
Total red cells	..	..	5,670,000 per c.mm.
Colour index	..	..	0.84
Total white cells	..	..	6,400 per c.mm.
Lymphocytes	..	..	35.0 per cent
Polymorphs	..	..	55.0 "
Eosinophils	..	..	1.0 "
Large mononuclears	..	..	7.0 "
Mast cells	..	..	1.0 "
Myelocytes	..	..	1.0 "
Total cells counted..	..	..	200
Arneth index of polymorphs	..	{	1 2 3 4 5 5 34 40 19 2 per cent
Average per cell (normal : 2.76)	..	..	2.79
Iodophilia	..	..	Nil
Calcium index	..	..	Nil
Malarial parasites	..	..	Nil

Results of Urine Analysis :—

Source	..	..	24 hours
Specific gravity	..	..	1012
Urea (normal 2.2 per cent)	..	..	0.8 per cent
Total acidity (normal urine = 2 c.c.	..	..
N/1 NaOH per cent)	..	..	1.0 c.c. per cent
Albumin coagulable	..	..	Nil
Xanthoproteic reaction	..	..	Nil
Sugar—Benedict's test	..	..	Nil
Acetone and diacetic acid (Rothera's test)	..	..	Nil
Amino-acid derivatives :			
Tryptophane as Skatoxyl	..	..	Nil
" " Indican	..	..	+
" " Indirubin	..	..	Nil
" " Indol	..	..	Nil
Tyrosine " Tyramine	..	..	+
Bile salts	..	..	Nil
Bile pigments	..	..	Nil
Phosphates on boiling	}	..	Nil
" " neutralization		..	
Organisms	..	..	Streptococci and <i>B. coli</i>
Deposit on cooling	..	..	Slight
" " centrifuging	..	..	Pus cells and organisms. No cystin crystals were observed.

Family History.—Father, age 82, and mother, age 80, are still living, and enjoy reasonable health. They were not related before marriage.

One brother and two sisters suffered from similar kidney calculi:

- (1) One sister died after having one kidney opened some years ago.
- (2) A second sister had her right kidney removed about four years ago and has apparently had no further trouble, although she is in a state of chronic ill health. The kidney was enormously enlarged and adherent to stomach and bowels, and over two hundred cystin stones were found in it.
- (3) A brother two years senior has an abscess in one kidney and stones in the other.

The patient has three children, and states that the oldest girl has the same sediments in her urine as he has himself.

Patient was admitted to King's College Hospital in February, 1924. He felt there was a large stone in his bladder which he could not pass per urethram.

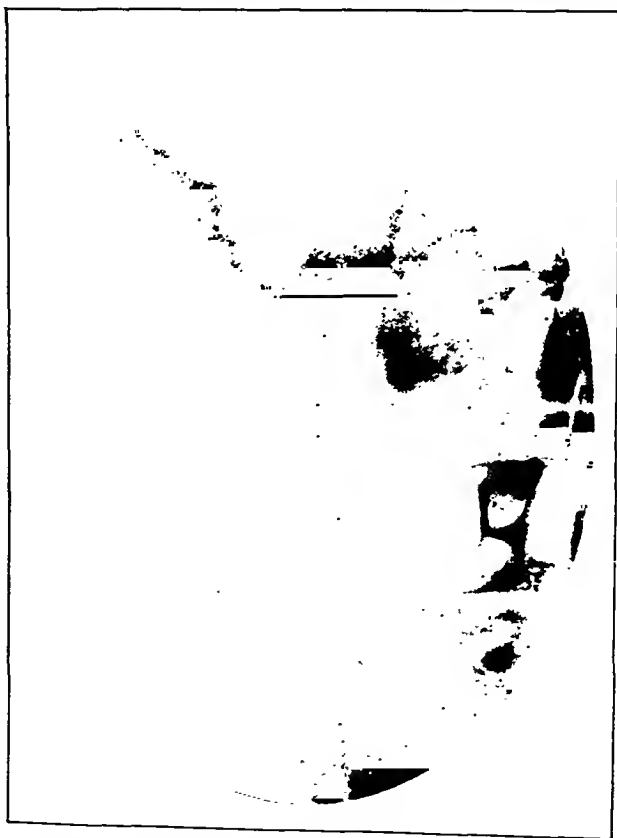


FIG. 264.—The radiograph shows a small collection of cystin stones in the lower pole of the left kidney.

He brought up a few of some dozen small stones which he had recently passed. They are small rough bodies, the size of a large pea, of yellow colour and waxy appearance. Analysis of one showed it to be entirely composed of cystin.

X rays showed a small collection of stones in the pelvis of the left kidney, with one low down in the ureter and two in the bladder—a large and small one (Figs. 264, 265).

The urine was pale yellow, and slightly turbid and oily. There was a slight yellow deposit. Reaction was alkaline. Much pus was present, and *Staphylococcus albus* and *Bacillus coli* were cultivated. No cystin crystals were found in the urine even after acidifying with acetic acid and acetone. The chemical reactions of cystin were absent.

The large stone was crushed by Sir John Thomson-Walker under stovaine, and shortly afterwards the small stone seen in the skiagram was passed. The patient left hospital the next day.

Repeated specimens of urine were sent up by the patient, but no cystin



FIG. 265.—One stone is shown in the bladder, another in or near the left ureteric orifice, and a third in the left ureter a short distance from the orifice.

was found on daily examination. On April 14, almost two months after litholapaxy, a specimen was received by post which contained cystin crystals in abundance. The specimen was different from those previously received. It was darker, more oily, and yielded a heavy deposit. It had a sweetish odour. Pus cells were abundant. On standing for a few days, the characteristic smell of hydrogen sulphide developed. Cadaverin and putrescin were looked for in this specimen by benzoylation, but I could detect none.

Specimens received from the parents contained no cystin. The urine of all three children was dark and yielded a heavy deposit. No cystin was found in either, but very characteristic tyrosin crystals were found in the urine of the youngest child, a girl of 4.

The patient lives some hundred miles away, and experimental work is impossible. As far as it has been exploited, the case seems to add little further to our present knowledge of the subject, beyond the fact that it definitely establishes a condition of intermittent cystinuria. Two years ago, a very thorough search for cystin in the urine was negative. For two months only one specimen was obtained in which it was found. All specimens were searched regularly without result until the specimen received on April 14 showed cystin in abundance. Two cases of temporary cystinuria have been previously recorded by Warburg, and Senon and Lewis.

The familial nature of the disorder is brought out strongly, particularly along horizontal lines, i.e., the brothers and sisters of the patient. The urine of the children is not above suspicion. Only one specimen from each child was examined, and although repeated attempts to find crystals bore no fruit, yet the urines were far from normal, and I think it highly probable that at some time or other cystin could be found. The discovery of tyrosin in the youngest child is hard to explain apart from cystinuria.

The gouty attacks lead one to think of Abderhalden's famous case of the infant who died of so-called 'inanition', and in whose tissues deposits of cystin



FIG. 266.—The print is of various urinary stones X-rayed simultaneously, to show their relative opacity. A, Oxalate. B, Phosphate. C, Collection of small cystin stones. D, Uric acid stone.

crystals were found. Although there is no definite evidence that the acute attacks of arthritis are in any way related to the error of metabolism, it seems reasonable to suspect an intra-articular deposit of cystin similar to the deposit of sodium biurate in gout.

The liability to skin disorders finds a parallel in the case described by Miller which displayed a 'stubborn urticaria'. Miller actually found cystin crystals in the blood.

The prodromal attacks of dyspepsia do not occasion much comment, but it is difficult to associate the attacks of blepharitis with the renal condition. In Tennant's case of a young woman, age 21, the only symptom beyond hæmaturia was that "her eyes filled with tears during urination". Reflex lachrymation can be readily understood, and probably occurred in the case quoted, but there is nothing to explain the blepharitis.

There is a popular conception that cystin stones cast a poor shadow with X rays. As Morris pointed out some years ago, cystin calculus is second only in X-ray opacity to oxalate calculus. The accompanying photograph (Fig. 266) shows a comparison between urinary stones given the same exposure.

Treatment, as in all disorders of metabolism, is disappointing. Rationally, treatment should be directed towards arresting the excretion of cystin by the kidneys as a prophylactic against calculus formation. Diet has little effect. It has been shown that ingestion of cystin by mouth has no influence upon the output of cystin by the kidneys, although it increases the output of organic sulphates. Cystin is soluble in alkaline media; thus, by keeping the urine alkaline, cystin crystals should not be formed. Klemperer and Jacoby state that administration of 6 to 10 grm. of sodium bicarbonate causes complete cessation of cystinuria. In cases in which stones have already been formed, this treatment is of no avail.

Choleic acid may be given—a treatment based on the hypothesis that endogenous cystin should normally become the taurin of the bile salts, and that its excretion as cystin is due to lack of choleic acid with which it can conjugate.

In this case, as in many quoted, bowel sepsis determines the pelvic infection which furnishes the irreversible colloid that glues the crystals into calculi. An attempt should be made, therefore, to allay fermentation in the bowel by intestinal antiseptics, such as salol and kerol, coupled with urinary antiseptics. A course of vaccines may be tried. In the case described, a vaccine was prepared from the faecal strains enumerated above, the dose rising from 0.1 c.c. to a maximum of 1.0 c.c., at intervals of from five to seven days. This treatment gave rise to an eczema which persisted throughout the course, and seemed to have little effect upon the condition.

The question of operative measures must receive consideration. The risks of nephrectomy in this case would, I think, be unjustifiable. Removal of the stones by nephrotomy would be useless. The infection of the pelvis would again determine the formation of new stones. Southam, however, states that cystinuria may cease with operation, and quotes a case which remained free from cystin for fourteen years after operation.

The case described is being treated with kerol and urinary antiseptics, and stones too large to be passed per urethram are dispersed by crushing as they arise.

I wish to thank Sir John Thomson-Walker for permission to investigate and publish this case, and Mr. C. P. G. Wakeley for his advice.

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RETROPERITONEAL CATHETERIZATION OF THE URETERS.

BY ANDREW FULLERTON, BELFAST.

It occasionally happens that for some reason it is impossible to catheterize the ureters by the ordinary method. The bladder may be so extensively ulcerated, or so irritable, that enough fluid cannot be retained; or the medium may be so clouded by blood, pus, uræus, debris, etc., that the ureteral orifices cannot be seen. The ureter, or its orifice, may be stenosed, displaced, or distorted by some local condition, as, for example, a tumour inside or outside the bladder. A fold, or some unusual conformation of the intramural portion of the ureter, or spasm, may prevent the passage of the catheter. A large endovesical prostate, or other projecting tumour, may also give rise to insuperable difficulties by placing the ureteral orifices out of view or out of reach. The operation about to be described was designed with the object of surmounting any of these difficulties.

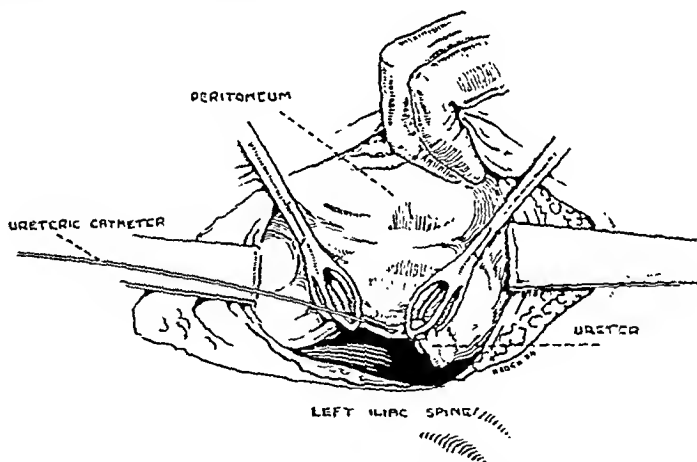


FIG. 267.—Showing peritoneum carrying ureter stripped back from pelvic wall. The ureter is shown fixed between two points by Lane's tissue forceps. The introduction of a ureteral catheter is shown. The segment of ureter between the forceps should be taut, and the ureter should be shown less curved on the right side of the figure. The catheter is entering a small slit in the longitudinal axis of the ureter.

An incision about 4 in. long is made in the lower iliac region, and the external oblique aponeurosis split in the direction of its fibres. After retraction, the internal oblique and transversalis muscles are similarly split in the direction of their fibres. The edges of the wound are now widely retracted, and the peritoneum is stripped from the iliac fossa and the lateral wall of the pelvis until the external iliac artery is reached. It will be found that the ureter has been reflected with the peritoneum, and can be recognized on its deep

surface as a thin strap, accompanied by longitudinal vessels. A section, about 2 in. long, of the ureter is steadied by two pairs of Lane's tissue forceps, each of which surrounds the ureter without damaging it. By traction on these forceps the required area of the ureter can be made taut, and brought, with the adherent peritoneum, towards the surface of the wound. A short longitudinal incision is made into the lumen, and a catheter introduced towards the renal pelvis (*Fig. 267*). This is done on both sides, and specimens are obtained from both kidneys. When sufficient urine has been collected, the small slit is accurately closed by a double layer of fine continuous catgut suture, excluding the mucous membrane. A small glove-drain is introduced, and the wound closed in the usual way.

This procedure was carried out in the following case, that of a male, age 45. About two years previous to my examination he began, rather suddenly, to suffer from frequency of micturition. This had continued ever since, and was accompanied by the passage of 'blood and corruption' in the urine. If he held his urine too long he had pain in the penis. During the night, if he fell asleep, he might retain for a maximum of two hours, but as a rule he was obliged to micturate every ten minutes, day and night. I examined him on Aug. 27, 1923. He appeared to be a strong, healthy man. Nothing could be made out on abdominal examination. Per rectum, he complained of pain on pressure over the base of the bladder. Nothing abnormal could be detected in the prostate or testes.

The urine was cloudy, alkaline, sp. gr. 1010, contained phosphates, pus, some blood-cells on microscopic examination, and a small amount of albumin. Sugar was absent. A few clumps of bacilli resembling tubercle bacilli were found in the urine, but the bacteriologist was not quite satisfied as to their identity. The bladder held, with great difficulty, about 2 oz. of fluid, and the patient strained and struggled so much that cystoscopy was almost impossible. The right side of the bladder appeared fairly normal. On the left side there was a good deal of redness, and the orifice of the left ureter was obscured by a small cystic swelling. There was a good deal of bleeding from the region of the neck of the bladder, which prevented a satisfactory examination. Attempts were made to catheterize the ureters, but although the points of the catheter engaged the orifices, they could not be passed farther. About a fortnight later, further attempts were made, after the injection of indigo-carmin subcutaneously and under an anæsthetic, but again without success. The ureters were then exposed in the iliac regions. The left side was first dealt with, and then the right. Both ureters were dilated and their walls were much thicker than normal. I attributed this to back pressure from compression of the intramural portion of the ureters by overaction of the bladder muscle. A small slit was made into each ureter, so as to admit a ureteral catheter, and specimens were easily obtained. On conclusion of the observation the openings were accurately sutured with fine catgut on a round needle, and the wounds in the parietes closed. Healing took place by first intention.

The specimen from the right side was slightly cloudy, with a blue tinge. was neutral in reaction, had a specific gravity of 1010, and contained a small amount of pus and a trace of albumin. An odd red cell and some ureteral epithelial cells were seen on microscopical examination. The chloride output

was 0.3 per cent and the urea 1.4 per cent. Staphylococci were found in pure culture. The specimen from the left side was clear, with a pale-blue tinge, acid in reaction, had a specific gravity of 1020, and was free from pus and albumin. A few red cells and some ureteral epithelial cells were seen on microscopical examination. The chloride output was 1.1 per cent, and the urea 1.9 per cent. Staphylococci were absent.

An autogenous vaccine was given, and the bladder irrigated daily with weak nitrate of silver solution. The frequency soon diminished, so that the patient could retain for one to one and a half hours. He was then sent home, supplied with the vaccine, which was administered by his medical attendant. A letter from the latter, dated April 5, 1924, states that "the patient is very well. For days together he has no trouble in the bladder. Micturition is generally normal. He eats well, sleeps well, and has put on some flesh." I believe that, when the over-action of his bladder has passed off, the obstruction at the entrance of the ureters will disappear.

In this case one would have been justified in suspecting the left kidney from the cystoscopic appearances, and the condition of the left ureter when exposed would have confirmed these suspicions had not the right ureter also been examined. It is probable that, if the bladder had been opened, attempts to catheterize the ureter by this route would have failed on account of the obstruction, which was sufficient to cause dilatation and what appeared to be hypertrophy of the walls of both ureters.

A recent paper by N. P. Rathhurn¹ will tend to revive interest in a method which most of us who practise urology have used on occasions. The author of this paper recommends suprapubic cystotomy and catheterization of the ureters through the open bladder for certain cases of tuberculosis in which it is impossible to catheterize the ureters in the usual way on account of limited capacity and inability to wash the field free of blood, pus, and tenacious mucus. He quotes Marion, Carlier, and Pasquereau in support of this procedure, and Cathelin as mentioning it only to condemn it. The last-mentioned author recommends, as an alternative, one of three measures, (1) the segregator, (2) lumbar incision with aspiration of urine from the kidney pelvis, and (3) temporary ligature of the ureter on the supposed diseased side through a groin incision and collection of urine through the bladder from the supposed healthy side.

Speaking of the attendant risk of cystotomy, Rathhurn points out that cystoscopy may be, and often is, attended by quite as much shock and discomfort, and is not entirely devoid of risk, and, furthermore, does not always accomplish its aim. With this expression of opinion most surgeons will be in thorough agreement. The risk of a suprapubic fistula which fails to heal is also mentioned.

In a recent case of extensive ulceration of the bladder, I failed to find the ureteric orifices even after wide exposure by cystotomy, and resorted to the expedient of stripping back the peritoneum from the bladder till the ureters could be felt and traced to their junction with the latter. The position of the vesical ends of the ureters being thus located, we succeeded in introducing the catheter through the open bladder. Tuberculosis of the kidney being excluded by examination of the specimens thus obtained, as much as possible of the ulcerated surface of the bladder was cut away with scissors, with the

result that the patient was completely cured of intolerable suffering which had lasted for several years. In this case it would, perhaps, have been easier and safer to have performed the retroperitoneal exposure of the ureters just described.

CONCLUSIONS.

1. It may be impossible to catheterize the ureters by the ordinary method.

2. The ureter can be exposed for catheterization by stripping inwards the peritoneum after an incision in the parietes similar to that used for appendicectomy.

3. In tuberculosis of the kidney, if a thickened ureter be found on one side, it need not be further disturbed. All that is necessary is to obtain a specimen from the opposite ureter.

4. With careful technique and accurate suturing there need be no extravasation of urine.

5. The actual quantity of urine secreted by a kidney can be ascertained:
(a) By using a catheter of sufficient calibre to fit the ureter snugly; or
(b) By compressing the ureter round the catheter so as to avoid leakage by the side of the latter.

6. The specimens so obtained are free from any contamination from the bladder contents.

I am greatly indebted to Mr. C. A. Keogh, my resident pupil, for the accompanying drawing.

REFERENCE.

- ¹ RATHBURN, N. P., *Surg. Gynecol. and Obst.*, 1924, xxxviii, No. 3.

FIBROMA OF THE ABDOMINAL WALL.

BY M. J. STEWART, LEEDS, AND T. B. MOUNT, SHEFFIELD.

SUMMARY.

I.—INTRODUCTION.

II.—HISTORICAL SUMMARY.

III.—REPORT OF SEVEN PERSONALLY OBSERVED CASES.

IV.—TABULAR SUMMARY OF A RECENT SERIES OF 66 CASES.

V.—CLINICAL AND PATHOLOGICAL ASPECTS.

1. Etiology.
2. Morbid anatomy and histology.
3. Signs and symptoms.
4. Diagnosis.
5. Course and prognosis.
6. Treatment and results.

VI.—SUMMARY AND CONCLUSIONS.

I. INTRODUCTION.

FIBROMA of the abdominal wall or desmoid tumour, is a condition which has had a considerable amount of attention paid to it at various times during the last sixty-five years, and the main facts of its natural history are now well established. Of somewhat infrequent occurrence, it is nevertheless a clinical entity of great general interest and some importance, and does not merit the comparative neglect into which it seems to have fallen of late in this country. In structure a true fibroma, it owes its clinical and pathological interest mainly to its site and to the fact that about 80 per cent of the cases occur in women who have borne children.

By the kindness of Sir John Bland-Sutton, Mr. Victor Bonney, and Mr. Giles, of the Chelsea Hospital for Women, and of Professor Hellier, Mr. L. R. Braithwaite, and Mr. William Gough, of Leeds, we have had the opportunity of studying seven cases of this disease. For this reason, and also as it is now twenty years since the publication of Pfeiffer's comprehensive monograph, we have thought it worth while to review the subject afresh, and to collect as far as possible all the recently reported cases. We have also included in our analysis eighteen cases from the older literature not given by Pfeiffer, making, with our own seven, a total of sixty-six. Only cases in which a reasonable amount of detail is given have been included.

II. HISTORICAL SUMMARY.

Labbé and Remy, in their monograph published in 1888, divide the history of abdominal-wall fibromas into two periods, a ten-year period prior to 1860, during which nine isolated cases were reported by various observers, and

the period from 1860 onwards, when the condition was recognized as a definite entity, and various series of collected cases were published. Of the nine cases in the first period, two occurred in France, one in Belgium, four in Germany, and one each in Sweden and in England. The first four were reported in 1850, those of Sappey (1850) and of Limauge (1850) being exceptional in that the tumours occurred in men, while those recorded by Langenbeck (1850) were in women who had borne children. An early report of two cases by Macfarlane of Glasgow (1832) was evidently unknown to Labbé and Remy. There can be little doubt from the details given that these were examples of fibroma of the abdominal wall, although the first is described under the title, "organized sarcomatous tumour between the layers of the abdominal muscles", and the other as a "fibrocartilaginous tumour" in the same situation.

The fibrous nature and benign character of these tumours were recognized from the outset, although there was much controversy as to their point of origin, and, to a less extent, as to the mode of treatment. Bouchacourt (1851) was the first to show the diagnostic importance of immobilization of the tumour when the abdominal muscles were thrown into action, while Santesson (1855) noted the liability to sudden increase in size at a given moment. Paget's (1856) case is important as showing the possibility of traumatic origin.

In 1860 an important discussion, initiated by Huguier, took place at the Société de Chirurgie. Huguier (1860), who had seen four cases, recognized that he was dealing with a distinct entity, and, while he correctly stated the fibrous nature of the growth, was responsible for an anatomical error which continued to colour French surgical practice for the next fifteen years. This was that the tumour was invariably attached by a pedicle to the pelvis, from the periosteum of which Huguier supposed that it took origin. He suggested section of the pedicle as a method of treatment. Earlier observers had practised excision, and in the discussion at the Société de Chirurgie Verneuil expressed the view that the tumour should be excised if not adherent to the peritoneum. Huguier's cases and those of Gosselin and Gubler formed the basis of a thesis by Bodin (1861), who called them peri-pelvic fibrous tumours. In the following year Nélaton (1862) published a clinical lecture on the subject, but changed the name from intra- and extra-pelvic tumours to tumours of the iliac fossa and iliac crest. He recognized the close connection with pregnancy and parturition, but accepted the pelvic periosteal theory of their origin. He advocated treatment by excision, but thought that small tumours might be dealt with by section of the pedicle.

While French surgeons were thus going off on a side track, observers in other countries (Cornils 1865, Buntzen 1868, Boye 1873, etc.) were referring neither to a pedicle nor to an osseous origin, a musculo-aponeurotic origin and treatment by excision being equally accepted. In France it was not until 1875 that Guyon (1875) put right the error initiated by Huguier. In the same year Suadicani (1875) made the great advance of applying Listerian antiseptic methods to the extirpation of these tumours. Prior to that time operators had the possibility of peritonitis always before them, especially in cases where the tumour was adherent to the peritoneum; afterwards, radical measures could be adopted with almost complete safety.

The earlier observers had spoken of this tumour as a fibroma or fibroid,

or as a fibrous or fibroplastic tumour. Sanger (1884) first applied the term desmoid, originally used by Johannes Muller (1838) to designate tumours of tendon-like consistency. It is interesting to note that while French authors have continued to use the term 'fibrome de la paroi abdominale', most German and many British and American writers have followed Sanger in using the term 'desmoid'. The French usage has led to greater precision, inasmuch as the term has been strictly confined to true fibromas, whereas desmoid has sometimes been used to include definitely malignant (fibrosarcomatous) tumours. Sanger was responsible for an important operative innovation. He advised resection of the peritoneum in cases where this membrane was adhered to the growth, rather than decortication, which had been the method previously in vogue.

III. REPORT OF SEVEN PERSONALLY OBSERVED CASES.

Case 1.—G. F., age 26, was admitted to the Chelsea Hospital for Women under Mr. Victor Bonney on Sept. 26, 1911. She had borne one child a year and eleven months before, and had had an easy and non-instrumental labour. There was no history of trauma or of any undue abdominal strain, and she looked robust. About eight months before admission she accidentally discovered a lump in the abdominal wall immediately above and to the right of the umbilicus. It gave rise to no symptoms, but felt "like a hardness in the muscle about the size of a penny".

ON ADMISSION the tumour was the size of the closed fist, and it appeared to be in the substance of the right rectus muscle.

AT OPERATION this was confirmed, and it was further found that the growth was adherent to both anterior and posterior rectus sheaths, and to the peritoneum, while the muscle fibres above and below seemed to disappear into its substance. The tumour was freely excised, together with portions of the rectus sheath and peritoneum. There was free hemorrhage, and the large gap in the abdominal wall was closed with difficulty with strong silk mattress sutures. Union was satisfactory, and five months later the patient was in good health, free from any sign of recurrence.

Case 2.—B. M., age 34, was an in-patient of the Chelsea Hospital for Women under Mr. Giles from July 7 to 28, 1911. She had four children aged respectively 6, 4, and 3 years, and 16 months. There had been a miscarriage eight years before. The first three labours were severe and rather prolonged, the first being instrumental, while the fourth was easy. She had severe abdominal pain after the last confinement, and presently noticed a lump in the lower part of the abdomen. She got up at the usual time after delivery, and had no further trouble until shortly before admission to hospital, when she sought medical advice on account of increased loss of blood at the menstrual periods.

ON ADMISSION the patient was strong and healthy-looking, and abdominal examination revealed an ill-defined tumour above and to the left of the symphysis pubis. The uterus was bulky, and bimanual examination seemed to show that the hypogastric tumour was connected with it. A diagnosis of subserous fibroid was therefore made.

AT OPERATION a median suprapubic incision was made, when the entire tumour was found to be embedded in the lower end of the left rectus muscle. All the deeper and outer muscle fibres seemed to terminate abruptly in the growth, and it had to be cut freely out of the muscular substance. It was also adherent to the peritoneum, which was opened in removing it. The gap was drawn together with strong silk mattress sutures and the wound healed satisfactorily. Seven months later the patient was in perfect health and without any signs of recurrence.

Case 3.—E. G., age 35, was an in-patient of the Chelsea Hospital for Women under Mr. Bland-Sutton from Feb. 26 to March 20, 1900. Her first confinement,

Jan. 1890, had been non-instrumental and easy, her second, April 1895, very difficult and prolonged, and her third, two years and a half later, also difficult. She stated that her second confinement left her with a feeling of weakness in the right inguinal region, which became more marked and was accompanied by pain in the same situation during the latter half of her third pregnancy. The presence of a tumour was first noticed about six months after delivery, and at the time of admission to hospital it had reached the size of a large orange.

AT OPERATION the tumour was found to be firmly embedded in the substance of the abdominal wall, and to be adherent posteriorly to the fascia of the internal oblique. It was excised without opening or injuring the peritoneum, although a number of small portions had to be taken away separately after removal of the main mass. The wound was closed with strong silk, and recovery was uneventful and union satisfactory. Eleven years later the patient reported herself as well and with no sign of recurrence.

Case 4.—E. B. S., age 24, was an in-patient of the Chelsea Hospital for Women under Mr. Bland-Sutton from March 13 to 27, 1903. She had two children, the youngest a month old. Fourteen months before admission she had first noticed a lump, the size of a walnut, in the right iliac region. It was painless, and grew slowly, but at the time of the birth of her second child there was a rapid increase in size.

ON ADMISSION the tumour had attained the size of a very large orange. It was of firm consistence, painless, slightly movable, and seemed to be situated in the substance of the abdominal wall. There was no adhesion to the skin.

AT OPERATION the tumour was found to be firmly adherent to the musculo-aponeurotic structures of the abdominal wall. It was found possible to strip off the peritoneum without injury. Recovery was interrupted, but the after-history could not be obtained.

Case 5.—E. S., age 40, was admitted to the Hospital for Women and Children, Leeds, under Mr. William Gough, Oct. 22, 1921. She had had a stillborn full-time child eighteen months previously. Six months before admission she accidentally discovered a lump in the left side of the abdomen, just above the middle of Poupart's ligament. It had not appreciably increased in size since that time, but had given

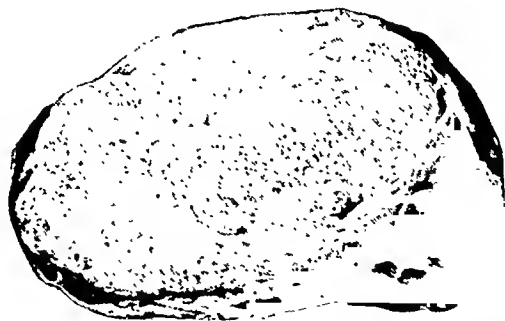


FIG. 268.—Fibroma of abdominal wall, on section, natural size. *Case 5* in this series. The fibrous character of the growth and the lack of definition at the margins are shown.

rise to neuralgia of moderate intensity. Her general health had always been good, and she had had but the one pregnancy. There had been no menstrual irregularities. On examination a densely hard oval mass *about* the size of a hen's egg was found, lying obliquely about 2 in. above the inner end of Poupart's ligament. It was fairly movable, but immediately became fixed when the patient was caused to contract her abdominal muscles. The inguinal canal seemed to be free, and vaginal examination revealed nothing abnormal.

AT OPERATION an incision 2½ in. long was made over the centre of the tumour in the line of the internal oblique muscle. The several layers of the abdominal wall were divided, and the tumour was then found to lie in the muscular tissue of the internal oblique and transversalis muscles, under cover of and attached by a broad pedicle to the conjoined tendon at its lower end. A fair margin of muscle was excised with the tumour, which was free and encapsuled on its anterior aspect, but firmly adherent to muscle behind and at the margins. This adhesion was particularly noticeable at the upper and outer and lower and inner poles of the growth, which seemed to merge completely with the surrounding muscle. The peritoneum was not involved. After removal of the growth, the muscular and fascial structures were brought together, and, more particularly, the conjoined tendon was stitched down to Poupart's ligament, as in Bassini's operation. The wound healed without difficulty and the patient was discharged 'well'. She was seen two years and six months later, and found to be in excellent health and free from any sign of recurrence. She was still subject to local attacks of pain.

The tumour on section (*Fig. 268*) was found to consist of whorls and strands of dense fibrous tissue, and at the poles the fusion with surrounding muscle was well seen. The colour was rather pinker than that of an ordinary fibroma.

Case 6.—G. M., age 23, was admitted to the General Infirmary, Leeds, under Mr. L. R. Braithwaite, Feb., 1922. She was unmarried and had borne no children. For four years there had been a steadily growing tumour in the left iliac region, which, at the time of admission, extended from the costal margin to below the anterior inferior spine of the ilium. She had been in hospital in Sept. 1921 and had had a portion of the growth removed. Microscopically it had the characters of a fibroma. Slight pain had been constantly present, with occasional exacerbations. The general health had been good and menstruation normal. At the time of her second admission the tumour had reached the size of the fetal head, and was apparently adherent above to the tips of the 11th and 12th ribs, and below to the crest of the ilium. There was practically no mobility.

AT OPERATION, Feb. 9, a curvilinear incision was made round the edge of the tumour, which was found to be infiltrating the gluteal muscles below. On its deep aspect, the growth was in contact with peritoneum, from which, however, it was readily stripped. The tumour was excised, together with a margin of infiltrated muscle, the tips of the 11th and 12th ribs, and a portion of the crest of the ilium. A very large cavity remained, which was partially closed by approximating the internal oblique to the iliacus, and the transversalis to the quadratus lumborum. A drainage tube was then inserted. Healing was long in taking place, as the large gap had to granulate up from the bottom. When the patient was seen six months later the wound was completely healed, but a large and unsightly scar remained. Two years and two months after operation she was in good health and free from recurrence, and she had recently married.

Case 7.—This is an example of a fibroma arising in the scar of a former abdominal operation wound. The patient, A. S., age 31, was admitted to the General Infirmary, Leeds, under Dr. Hellier, July 24, 1913. She was married, and had borne one child. In Oct., 1911, she had had an operation for ovarian cyst, complicated by gangrenous appendicitis with peritonitis, and soon afterwards she noticed a hard lump beneath the upper part of the scar. This was fixed to the skin but was not tender on pressure, though there was some discomfort when the clothes pressed on it.

AT OPERATION a solid tumour the size of a pigeon's egg was removed from the abdominal wall. It lay between the recti muscles at the level of the umbilical region and involved both muscles as well as the peritoneum. Elsewhere it appeared to be encapsulated. The peritoneum was opened during the course of the operation. The patient made an uninterrupted recovery, and when seen eleven years later was in excellent health and free from recurrence. For some time after operation there had been slight weakness and bulging of the scar, but this improved greatly during the war, when she served as a post-woman for three years. She now has a child 3 years old, both pregnancy and parturition having been uneventful.

IV.—TABULAR SUMMARY

CASE NO.	YEAR OF PUBLICATION	AUTHOR	SEX	AGE	DURATION IN YEARS	PREG-NANCIES	TRAUMA
1	1832	Macfarlane 1 ..	M.	22	2		Severe c.
2	"	" 2 ..	F.	26	3	0	Trauma
3	1880	Allen	M.	56	6		
4	1882	Briddon	F.	27		3	
5	"	Wallace	F.	34	2-3	5	
6	1885	Jouon	F.	45	$\frac{6}{12}$		Trauma
7	1888	Reed 1	F.	33		4	Trauma
8	"	" 2	F.	34			
9	"	" 3	F.	19	3		Trauma
10	"	" 4	F.	25		2	
11	"	" 5	F.	32		0	
12	1894	Chretien	F.	31	$1\frac{0}{12}$	2	
13	1895	Fieux	F.	25	$\frac{4}{12}$	3	
14	1903	Abadie	F.	30	$\frac{10}{12}$	4	
15	"	Fredet 1	F.	31	$\frac{3}{12}$	3	
16	"	" 2	F.	24	$2\frac{6}{12}$	3	
17	"	Silberberg	F.	23	$\frac{10}{12}$	3	
18	"	Vernot	F.	21		2	Slight t
19	1905	Powers 1	F.	25-30		1	
20	"	" 2	F.	25-30		1	
21	"	" 3	F.	25-30		1	
22	"	Cullen	F.	30	3		
23	"	Eitel	F.	26	$\frac{10}{12}$		
24	"	Gross and Seneert ..	F.	73	10		
25	"	Montgomery	F.	30			
26	1906	Bidwell 1.. ..	F.	36	$1\frac{6}{12}$	1	
27	"	" 2.. ..	F.	33	$\frac{9}{12}$	7	

NT SERIES OF 66 CASES.

POSITION				SIZE	RESULT
ON TO MUSCLE	RELATION TO UMBILICUS				
<i>Obliques, etc.</i>	<i>At</i>	<i>Above</i>	<i>Below</i>		
+			+	Fist ..	Good recovery
+	+			Fist ..	Death from peritonitis 4th day
		+		2½ in. diam.	Healed well
+			+	9 in. × 5 in., wt. 2½ lb.	
			+	Cocoanut ..	Discharged well
				Very large ..	No recurrence in 1 year
+	+			Large ..	Practically disappeared spontaneously
				Small orange	
		+		5 cm. diam.	Good recovery
+			+	23 × 12 c.m.	Death from peritonitis
				45 cm. circ.	Shrinkage of tumour after electrolysis
+			+	Small orange	Discharged well in 20 days
+			+	2 fists, wt. 380 grm.	Discharged well in a few days
+			+	Fist ..	
			+	Small nut ..	
+			+	Turkey's egg	
+			+	Large orange	
+			+		
	+			Pullet's egg	1 case only traced: well after 1 year
	+			Small orange	
	+			Baby's fist	
+		+		13 × 7 cm.	
+			+	Fist ..	
			+	Very large ..	
				Very large ..	
+			+	Lemon ..	No recurrence in 10 years
		+		Small pear	Normal labour 8 months later

Continued on next page

IV.—TABULAR SUMMARY OF A E

CASE No.	YEAR OF PUBLICATION	AUTHOR	SEX	AGE	DURATION IN YEARS	PREG-NANCIES	TRAUMA
28	1906	Eccles 1	F.	37	$\frac{6}{12}$	2	
29	..	.. 2	F.	26	1		
30	..	.. 3	F.	35	$\frac{6}{12}$	3	
31	..	Firth	F.	29	$\frac{1}{12}$	3	Muscular ..
32	..	Schwarzschild 1 ..	F.	28	2	$\frac{1}{1}$	
33	..	.. 2	F.	30		2	
34	..	Siegal and Delval ..	F.	27	$\frac{7}{12}$	1	
35	1909	Krusen	F.	29	1	4	
36	..	Pfannenstiel ..	F.	61			Trauma
37	..	Stone 1	F.	56	20	1	
38	..	.. 2	F.	23	$\frac{1}{12}$	$\frac{1}{1}$	
39	..	.. 3	F.	35	Short	$\frac{1}{1}$	
40	..	.. 4	F.	18	Short	$\frac{1}{1}$	
41	..	.. 5	F.	23	$\frac{1}{12}$	1	
42	1910	Lockwood 1 ..	F.	15	2		
43	..	.. 2	F.	25			
44	..	.. 3	F.	24			
45	..	.. 4	F.	30			
46	..	.. 5	M.	32	14		
47	..	Morison & Drummond 1	F.	36		2	
48	..	2	F.	28		2	
49	..	3	F.	35		3	
50	..	4	F.	25		2	
51	..	5	F.	30		2	
52	1911	Senlecq & Chenot ..	F.	24	$1\frac{4}{12}$	$\frac{1}{1}$	
53	1915	Greig	F.	$1\frac{8}{12}$	1	0	
54	1916	Balfour 1.. ..	F.	44	14		Scar ..

OF 66 CASES—continued.

POSITION				SIZE.	RE-ULT.
TO MUSCLE	RELATION TO UMBILICUS				
<i>Oblique, etc.</i>	<i>At</i>	<i>Above</i>	<i>Below</i>		
+			+		No recurrence in 18 months
+			+		Well 2 months after operation
+			+	5 × 3 × 3 in.	No recurrence in 12 months
+			+	Child's head	No recurrence in 12 months
			+	Hen's egg	
+			+	Large fist ..	Went home well
			+	8 × 6 cm.	
			+	Fist	
					Excised 20 years ago. Slow recurrence
		+			
			+		
	+			8 × 5 cm.	
			+		
+			+		
+			+		
+		+			Recurred. Re-excised 1 yr. 10 months later
			+		
		+			Well after 5 years
			+		
			+		
		+			Recurred. Well 2 years after second removal
			+		
			+		Recurred in 2 years ; re-excised
		+		1 in. diam.	

Continued on next page

IV.—TABULAR SUMMARY OF A E

CASE NO.	YEAR OF PUBLICATION	AUTHOR	SEX	AGE	DURATION IN YEARS	PREG-NANCIES	TRAUMA
55	1916	Balfour 2 ..	M.	44	$\frac{9}{12}$		Scar ..
56	1918	Bevan	F.	30	$6\frac{6}{12}$	+	
57	1919	Danforth	F.	24	6	0	Scar ..
58	1922	Cahn	F.	24		0	Scar ..
59	..	Delbet	M.	41	17		Trauma
60	1924	Stewart & Mouat 1	F.	26	$\frac{6}{12}$	1	
61	..	.. .. 2	F.	34	8	5	
62	..	.. .. 3	F.	35	2	3	
63	..	.. .. 4	F.	24	$1\frac{2}{12}$	2	
64	..	.. .. 5	F.	40	$\frac{6}{12}$	1	
65	..	.. .. 6	F.	23	4	0	
66		.. .. 7	F.	31	$1\frac{6}{12}$	1	Scar ..

V. CLINICAL AND PATHOLOGICAL ASPECTS.

1. ETIOLOGY.

The chief points which require discussion under this head are pregnancy, trauma, and operation scars.

The close connection which exists between pregnancy and fibroma of the abdominal wall has already been referred to. In Pfeiffer's (1904) series of 400 cases 87·1 per cent were women, and in the 265 female cases where the facts are given, 250 or 94·3 per cent had borne children. In our series of 66

Table I.—AGE INCIDENCE (61 CASES).

AGE	FEMALE	MALE
0-10	1	0
11-20	3	0
21-30	33	1
31-40	16	1
41-50	1	1
Over 50	3	1

Pfeiffer's figures are as follows :—

15-25	41	Males commenced from 35-50.
25-35	146	
35-50	35	
Over 50	15	

ES OF 66 CASES—continued.

POSITION		RELATION TO UMBILICUS		SIZE	RESULT
ADHESION TO MUSCLE		At	Above	Below	
<i>n</i>	<i>Obliques, etc.</i>				
		+		2 in. diam.	"Complete recovery"
				2 cm. diam.	
				Hen's egg	Recovery
	+			Fist ..	
			+	Closed fist	No recurrence in 5 months
			+	1½ × 2 in. ..	No recurrence in 7 months
	+		+	Large orange	No recurrence in 1 yr. 9 months
	+		+	Very large orange	
	+		+	Hen's egg ..	No recurrence in 2 yrs. 6 months
	+	+		Fœtal head	No recurrence in 2 yrs. 6 months
				Pigeon's egg	No recurrence in 11 years

cases, the tumour arose in the scar of an old abdominal operation wound in 5. Of the remaining 61, 56 were adult females, 4 adult males, and 1 was a female infant; that is, 93 per cent of the cases were females. The occurrence or non-occurrence of pregnancy is mentioned in 45 of the adult female cases, and of these 40 had borne one or more children—89 per cent. If to this group of 45 cases the infant and the 4 male cases be added, it remains true to say that in 80 per cent of the cases in this series the tumour occurred in women who had borne children. The age incidence shows a corresponding restriction, the tumour being most frequently met with in the third and fourth decades.

In our series 7 cases gave a history of a blow or other injury to the affected part at some period antecedent to the appearance of the tumour. Two others gave a history of severe muscular strain or exertion.

Fibroma of the abdominal wall is of comparatively infrequent occurrence. Most surgeons see only a handful of cases even in the course of a long professional career. Labbé (1888) saw 10 cases in twenty years, Billroth (1888) 16 in twenty-three years, and Nélaton (1862) 15 or 20 in twenty-six years. At the Mayo Clinic (Nichols, 1923) 25 cases were seen in the sixteen years 1906–1922. The largest published series from one source is Pfeiffer's (1904), 40 cases from von Bruns' clinic at Tübingen, seen during a period of forty-six years. It is obvious, therefore, that this tumour is one of the rarer accidents of pregnancy, and the connection between the two has given rise to much speculation. Nélaton (1862) was the first to point out that pregnancy was an

almost invariable antecedent. He attributed importance to the congestion of parts about the pelvis during menstruation and following conception, but believed that the tumour took origin from the fibrous periosteum of the pelvis. Following on the general acceptance of the musculo-aponeurotic origin of these tumours Ebner (1880) and Herzog (1883) advanced the theory that they resulted from muscular rupture, either in consequence of a violent effort or from traumatism. This, however, failed to explain the age and sex incidence, and it remained for Labbé and Remy (1888) to suggest that muscular rupture during the violent contractions of labour was the real explanation. They drew comparisons with the formation of exuberant callus in bony fractures, and with keloid. Ordinary trauma or violent muscular contraction apart from labour would account for cases in males or in women who have not borne children, and indeed a history of such injury is often given. Säger (1884) did not accept the view of a muscular origin, and thought the tumour arose from the aponeurotic sheath. He was therefore opposed to Herzog's traumatic theory. Pfeiffer (1904) accepted Labbé and Remy's theory, and pointed out that Wischnewsky had shown that in pregnancy there is hypertrophy of the abdominal muscles coincident with the hypertrophy of the uterus, and strikingly different from the atrophy of the abdominal musculature met with in states of pathological distention such as ascites or ovarian cyst. He considered that Ribbert's theory was applicable to these cases. Aimé Guinard (1910) thought that fibromas of the abdominal wall originated in the intraparietal portion of the round ligament in the great majority of cases, and explained the sex distribution in this way. He doubted the importance of pregnancy, as he had met with three cases in young girls who had never borne children. He had also noted the presence of unstriped muscle fibres in many of the tumours which he had examined, and thought that they occurred almost invariably in the ilio-inguinal regions. He admitted, however, that some might be of aponeurotic origin, while those occurring in males he believed to be aponeurotic fibrosarcoma.

The occurrence of fibromata in operation scars in the abdominal wall is well recognized, but quite infrequent. *Case 7* in our own series is an example of this kind, the tumour making its appearance in the scar two years after laparotomy for ovarian cyst with gangrenous appendicitis and peritonitis. In our collected series of 66 cases there are 4 other instances, all following laparotomy, 2 from the Mayo Clinic reported by Donald C. Balfour (1916), and 1 each reported by Danforth (1919) and by Cahn (1923). Wyllys Andrews (1911) mentions two cases in which the tumour appeared in herniotomy scars.

For ourselves, we find the traumatic theory of the origin of these growths an attractive one, and especially do we agree with the views expressed by Labbé and Remy on the importance of the part played by the physiological trauma of labour. Fibroma of the abdominal wall is undoubtedly of musculo-aponeurotic origin, at any rate in the vast majority of reported cases, and the round-ligament hypothesis of A. Guinard is quite untenable. The anatomical position excludes the possibility of such an origin in many cases, and the unstriped muscle fibres described by this author are in all probability included striped muscle fibres which have undergone the peculiar metamorphosis to be described in the next sub-section. The analogy with keloid is

a very close one. The naked-eye and microscopic characters are almost identical, at least so far as the actual tumour tissue is concerned, the points of difference being really dependent on their site in the skin and muscle respectively. Keloid tends to be the more sharply circumscribed, and it lacks the characteristic muscular inclusions of the other. The element of individual predisposition clearly enters into both, since only a very small proportion of scars become keloidic, and only a very small number of parturient women develop fibroma of the abdominal wall.

2. MORBID ANATOMY AND HISTOLOGY.

1. **Number.**—Fibroma of the abdominal wall is almost invariably single. In Labbé and Remy's collected series of 100 cases there were 3 in which two tumours were present. In our series of 66 cases all were single.

2. **Topographical Distribution and Anatomical Relationships.**—In 56 of our series the exact position in which the tumours originated is stated. The relation to muscles and to the umbilicus is shown in *Table II*.

Table II.—POSITION OF FIBROMAS OF THE ABDOMINAL WALL (56 CASES)

<i>A.</i> —Relation to muscles:—			
<i>a.</i> In recti abdominis .. ..	..	..	29
<i>b.</i> In oblique and transversalis muscles ..	..	..	27
<i>B.</i> —Relation to level of umbilicus:—			
<i>a.</i> Above umbilicus .. ..	..	..	10
<i>b.</i> At level of umbilicus .. ..	..	..	9
<i>c.</i> Below umbilicus .. ..	..	..	37

These figures may be compared with those of Pfeiffer's larger series, where, in a group of 255 cases, 41 (16·1 per cent) were above the umbilicus, 26 (10·2 per cent) at the umbilical level, and 185 (72·5 per cent) below. There were 3 in the region of the loins. Of the group of 185 cases occurring below the umbilicus, 51 per cent were on the right side of the abdomen, 37 per cent on the left, and 12 per cent in the middle line.

The site of origin differs greatly in different cases, and when the tumours become large they encroach on other areas of the abdominal wall, or may even extend into the iliac fossa or pelvis. They never arise exactly in the middle line, but always a little to one side or the other.

The relations of these tumours to the muscles in which they lie vary with their size and point of origin. While still small they may be found completely embedded in the muscular substance, or, more often, attached to one or other of the fascial sheaths. As the tumour increases in size, its growth takes place along the line of least resistance, that is, in the direction of the muscle fibres, and it assumes in consequence a flattened, oval shape. It also tends to project from the surface of the muscle and to form attachments to surrounding structures, muscles, fasciæ, and bones. It was this secondary bony attachment which led to the erroneous conception of the 'pedicle' as an important and integral part of these tumours, and to Nélaton's theory of origin from the pelvic periosteum. Its frequency is shown by Pfeiffer to be considerable. In his collected series of 400 cases 65 (16·25 per cent) had bony connections, 35 with the ilium, 8 with the os pubis, 6 with floating ribs, and 1 with the spine.

In 2 cases there were attachments to both ilium and os pubis. It may be noted that in *Case 6* of our own personally observed series, the tumour, which was very large, was adherent both to the iliac crest and to the extremities of the 11th and 12th ribs. In a certain proportion of cases the tumour comes into direct contact with the peritoneum, and may become firmly adherent to it. This is most likely to occur if the tumour has attained a large size or if it is situated above the level of the umbilicus, where there is practically no extra-peritoneal cellular tissue. There appears to be no tendency to perforation of the peritoneum. An appearance of capsulation is frequently met with over certain areas, owing to the surface of the tumour being covered by a fascial sheath. Within the substance of the muscle the margins of the tumour are by no means sharply defined, especially at the poles, where the muscle fibres appear either to penetrate into the growth, or to terminate abruptly on its face. It is impossible to shell it out completely as has been stated by some authors.

The precise tissue of origin is uncertain. It may arise from the aponeurotic sheath of the muscle or from the intramuscular fibrous framework; possibly in some cases from one, in some from the other.

3. Gross Characters.—Fibroma of the abdominal wall when of small or moderate size is a densely hard tumour, and contrasts with the softer muscle in which it lies. When cut into, it is both hard and tough, and creaks under the knife. The cut surface is white or pinkish, and glistening, and the interlacing bundles of white fibrous tissue are usually well seen (*Fig. 268*). A number of minute red points, dilated thin-walled vessels, or tiny foci of hæmorrhage, are often present. When tumours attain a larger size they tend to soften in the centre, either from œdema or from mucoid degeneration, and in a few instances they become cystic. It would appear that the density of these tumours may depend to some extent on their site, for tumours removed from the iliac regions are harder and more densely fibrous than those arising in the rectus muscles. It is possible that tumours arising in the groin sooner reach the limits of muscle, and, becoming adherent to comparatively avascular fascial structures, have their own blood-supply interfered with to some extent.

Changes in the skin covering the tumour are unusual, except for a certain amount of thinning when the growth attains a large size. Exceptionally there is adhesion to the skin, which may become œdematous, indurated, or even ulcerated.

The associated lymph-glands do not become enlarged.

4. Size and Shape.—As a rule the tumour is discovered accidentally by the patient while it is yet small in size. As it is usually a painless affection in the earlier stages and little likely to cause discomfort, the patients delay seeking medical advice,* and by the time the case is seen by a surgeon the tumour may have attained a considerable size. In 40 cases of our series the size of the tumour at the time of operation is given, usually in the form of a comparison with familiar objects. These include a small nut, a pullet's egg,

* Of 41 idiopathic cases in our series, 21 (51 per cent) gave a history of less than one year, 13 (32 per cent) of one to three years, and 7 (17 per cent) of over three years.

an orange, a turkey's egg, the closed fist, the fetal head, and a child's head. *Table III* gives some indication of the longest diameter measurements of the 40 cases after reduction to mathematical terms.

Table III.—LONGEST DIAMETER IN 40 ABDOMINAL-WALL FIBROMAS.

Under 5 cm.	..	..	12
5-12 cm.	..	..	21
12-20 "	..	..	5
20-30 "	..	..	2

The large size of some of the tumours is remarkable: Gross and Sencert's (1905) weighed 6 kilo., Montgomery's (1905) 19½ lb., and Rokitsansky's (1880), the largest on record, 17 kilo. Tumours of small size are rounded or oval, and smooth on the surface. As they enlarge they become more oval, or pyriform, and may be either flattened, or bossed and lobulated on the surface.

5. Histology.—The following observations are based mainly on the material obtained from the seven original cases here reported. The structure is that of a fairly cellular fibroma occurring in striped muscle. The central portion of the tumour is clearly the oldest, and here the tissue approximates most closely to the adult type. The elongated fibrous tissue cells run in strands and bundles which interlace in all directions, after the manner of the unstriped muscle bundles in a uterine fibroid. At the periphery, where it is infiltrating the surrounding muscle, there is a tendency for the tumour to be somewhat more cellular; but nowhere is there anything in the character of the cells to suggest sarcomatous change. In spite of this the tumour is clearly of an infiltrating type. The absence of encapsulation or indeed of any sharply defined edge within the muscle is most noticeable, and this is true equally of the margins parallel with as of those transverse to the muscle fibres. It is only when the tumour is bounded by a fascial sheath that the appearance of encapsulation is produced.

The special features of the tumour are the inclusion in it of striped muscle fibres, and the sequence of regressive changes which these undergo. The earliest change is seen at the periphery, where the striped muscle is being infiltrated and broken up into its constituent fibres (*Fig. 269*). These become stretched and attenuated, and irregular in outline, while the transverse striation tends to disappear. The cytoplasm stains more strongly with eosin, but shows irregular bands and patches of fainter staining. So far the nuclei have

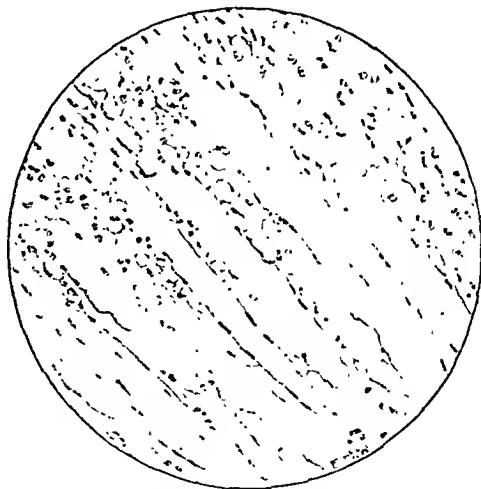


FIG. 269.—(High power). Margin of tumour, showing infiltration of striped muscle by fairly cellular tumour tissue.

remained in their normal position at the periphery of the fibre, but the next

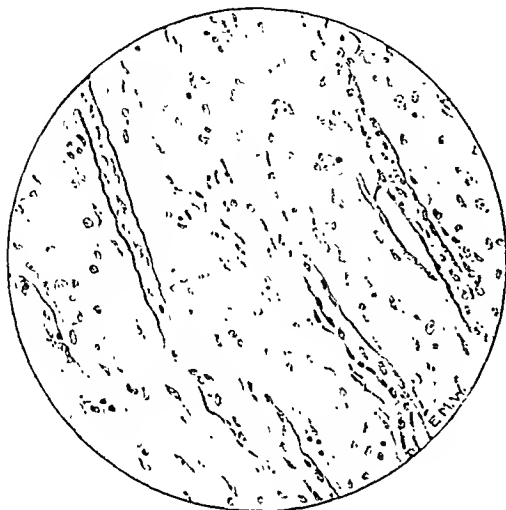


FIG. 270.—(High power). Striped muscle fibres embedded more deeply in the growth, and undergoing the peculiar reversionary change referred to in the text. Note the distribution of nuclei, and the general resemblance to unstriped muscle fibres.

phase shows them evenly distributed throughout the cytoplasm (Fig. 270). They are now elongated, rather thin, shrunk, and are present in considerable numbers, giving an appearance very similar to that of the discrete unstriped muscle bundles of the scrotum and elsewhere. We believe that it was this appearance which A. Guinard mistook for genuine unstriped muscle and which led to his enunciating the round-ligament theory of origin. These nuclei take a uniform and dense stain with the basic dye. The next change is a very remarkable one (Fig. 271). The cytoplasm swells out and becomes very homogeneous and strongly eosinophilic, while the nuclei also enlarge and become rounded or oval, and

vesicular, with well-stained chromatin. They also show quite definitely a peripheral or polar distribution, and as the muscle fibre is now fragmented, or seen in transverse or oblique section, the appearance comes to resemble very closely that of the foreign body or tuberculous giant cell. That these curious plasmodial masses are definitely derived from striped muscle fibres there can be no reasonable doubt, as the stages in the transition can be clearly traced. We interpret the appearances as indicating an assumption of a vegetative, non-functioning existence on the part of the fibre or its fragments, and not a mere degenerative change. It is a de-differentiation, a reversionary change similar to the plasmodial regression of striped muscle so accurately described by Durante (1902), and is brought about by certain ill-defined faults



FIG. 271.—(High power). A later stage in the reversionary process, formation of 'muscle giant cells'.

of nutrition or of innervation. There is therefore nothing specific, or pathognomonic of abdominal wall fibromas, about these changes. They are liable to occur wherever there is fibrosis of muscle, but they would appear to be particularly prominent in the case of desmoid tumours, perhaps because of the combination of factors of intramuscular origin of the tumour, progressive infiltration, and slow growth.

In fibromas of large size, especially those which have passed through a period of rapid growth, the centre of the tumour becomes myxomatous or mucoid, and many of the cells, now widely separated, assume a stellate form.

The blood-vessels of the tumour fall into two groups: (a) Well-formed thick-walled vessels, often with medullated nerves lying alongside. These are clearly the original vessels of the part, which have become surrounded by and embedded in the growth. (b) Simple, thin-walled vessels of embryonic type, mere endothelial tubes, often separated by a narrow myxoid zone from the surrounding fibromatous tissue. These appear to be the new-formed vessels of the growth itself.

3. SIGNS AND SYMPTOMS.

In the great majority of cases the tumour is discovered accidentally. Very often the occurrence of some slight trauma leads to examination, and to the discovery of a lump. This is due to its indolence and painlessness, which also account for the fact that when first discovered it has usually attained a size varying from a nut to a hen's egg. Exceptionally the tumour may be as small as an almond or even a pea, or it may have attained a large size. Subjective disturbances only make their appearance, as a rule, after the tumour has been discovered. There may be intermittent attacks of local or radiating pain, worst at the menstrual periods, and most marked in the case of the more rapidly growing tumours. Tumours situated in the groins are more liable than others to be painful, even when quite small in size.

Fibroma of the abdominal wall is a strictly local condition. It occurs usually in healthy subjects, and, as already indicated, chiefly in youngish women who have gone through one or more pregnancies. Even when the tumour has attained a large size it is exceptional for pressure symptoms to be present, and the signs and symptoms of intra-abdominal mischief are lacking.

While the tumour is still of small or moderate size, a hard, non-tender swelling is palpable in the abdominal wall. It does not implicate the skin, which can be moved freely over it, and, with the abdominal muscles relaxed, it can itself be moved about in certain directions with sufficient freedom to show that it is unconnected with any intraperitoneal structure. This can be further demonstrated by vaginal or bimanual examination. Perhaps the most important single sign is the fact that if the patient is caused to contract the abdominal muscles, the tumour at once becomes completely immobilized (Bouchacourt's sign), to recover its mobility when the muscles are relaxed. Subcutaneous tumours of the abdominal wall are rendered more prominent by such contraction, while intra-abdominal tumours usually become no longer palpable. The corresponding effect on a desmoid tumour will depend on its position in relation to the thickness of the abdominal wall. Even with the

muscles relaxed, these tumours are movable only in certain directions, viz., at right angles to the long axis of the muscle in which they lie.

Tumours of small or moderate size are round, ovoid, or pyriform, flattened or elongated. They are usually smooth on the surface, with well-defined margins, but may be bossed. Desmoids of large size tend to become lobulated, and are no longer uniformly hard. They are still movable in the way described unless they have contracted adhesions, and they are immobilized by muscular contraction. The patients now complain of the discomfort and inconvenience due to the size of the tumour, which tends to project forwards, or even to become dependent. The skin over it is liable to be irritated by friction of clothing, and to become indurated or even ulcerated. This in turn may lead to repeated hæmorrhages and cachexia.

4. DIAGNOSIS.

In tumours of small or medium size, not adherent to bony structures, the diagnosis is usually easy. There is a hard, painless tumour in the abdominal wall, movable against the long axis of the muscle in which it lies, and immobilized by muscular contraction. It has grown slowly, and there is a history (in most cases) of a preceding pregnancy. There is an absence of the symptoms of abdominal or pelvic disease, and the patients are usually young or middle-aged women in good general health.

The diagnosis is much more difficult in the case of tumours of large size, and especially those which have contracted adhesions to adjacent bones. In stout or muscular subjects with a deeply situated tumour an exact diagnosis may be impossible.

In the differential diagnosis various conditions have to be kept in mind, especially other forms of abdominal-wall tumour, tumours of the pelvic bones, and intra-abdominal tumours of various kinds. Cutaneous and subcutaneous tumours—fibroma (including keloid), lipoma, neurofibroma, etc.—are most readily differentiated by the absence of fixation on muscular contraction. Many of them are adherent to the skin, and some are multiple. Desmoids, especially those in the inguinal region, have to be distinguished from hernias, and more especially from small intraparietal epiploceles. Umbilical hernia and middle-line ventral hernias should not cause difficulty, as fibromas are never quite median in position.

Tumours of the pelvis, osteosarcoma, periosteal fibrosarcoma, chondroma, osteoma, may be simulated by large abdominal-wall fibromas which have become firmly adherent to the pelvis. The history will help in such cases, and in most, radiography should be able to settle the question.

Various forms of intra-abdominal tumour may simulate desmoid—tumours of the uterus and ovary, omentum, and gall-bladder, salpingitis, and appendicitis—but the differential diagnosis is usually not difficult.

The greatest difficulty arises in the differentiation of other deep-seated tumours of the abdominal wall—gumma, hæmatoma, intramuscular lipoma, sarcoma, and tumours of the round ligament. In diagnosis, the history and the exact site of the tumour are of the first importance. Round-ligament tumours are strictly limited as to site, sarcomas are usually of more rapid

growth than fibromas, and intramuscular lipomas of the abdominal wall are excessively rare. Gummata are soon accompanied by changes in the superjacent skin, there is a history of syphilis, and the Wassermann reaction may be positive. Hæmatoma, once formed, is stationary, and there is a history of sudden onset following trauma.

5. COURSE AND PROGNOSIS.

Fibroma of the abdominal wall shows considerable variation in its rate of growth in different cases. As a rule, growth is slow, especially in the earlier stages. Not infrequently there is a history that the tumour remained of small size for a number of months or years and then grew rapidly; in other cases growth is slow throughout. In Delbet's (1922) case the tumour took seventeen years to attain the size of the closed fist, in Fieux's (1895) it reached double that size in four months. Rapid growth throughout is exceptional, and should at once raise the suspicion of malignancy—that is, that the tumour is a fibrosarcoma and not a fibroma. The sudden onset of rapid growth in a tumour which had previously been growing slowly or had even been stationary is in an entirely different category. As Labbé and Remy have pointed out, this change is due not to a phase of rapid cellular proliferation, but to the onset of a mucoid or myxomatous change in the tumour, with great imbibition of fluid. *It does not indicate the supervention of malignant change in a previously simple tumour.* Indeed there is little or no evidence to show that a true fibroma of the abdominal wall ever becomes sarcomatous. In most of the published cases in which a sudden increase in the rate of growth has taken place the phenomenon has been definitely related to pregnancy. Most often it has occurred at some period during the course of pregnancy; less often it has followed parturition.

When tumours are left untouched, they may attain, as already mentioned, a very large size, and it is only then that serious impairment of the general health may be met with. Even in these late stages treatment by extirpation is always practicable, at least in so far as local conditions are concerned.

The prognosis in cases of fibroma of the abdominal wall is therefore extremely good. It is a benign growth which never metastasizes, and, even if untreated, is very unlikely to cause death. Cure can be effected by surgical removal of the growth, and if this is done completely there is no risk of recurrence. Even if the peritoneum has to be opened, or a portion of it excised, the operative mortality, in modern practice, is low. In our collected series there has been no operative death in the last thirty-five years, that is to say, in 55 cases.

Pfeiffer (1904) has analysed a series of 261 cases in which the operative treatment was presumably carried out by antiseptic or aseptic methods, but including many which date from the early days of the Listerian method. In 119 cases in which the peritoneal cavity was opened, the operative mortality was 8.4 per cent; in 142 cases in which it was not, the mortality was 2.1 per cent: giving a combined mortality of roughly 5 per cent.

In a few reported cases a second independent tumour has made its

appearance following removal of the first, just as, in one or two instances, two tumours have co-existed in the same individual. Treatment by excision of the new tumour is none the less efficacious.

6.5 TREATMENT AND RESULTS.

There is only one method of treatment, extirpation, which should be carried out at the earliest possible opportunity. The operation is perhaps less easy to perform than might be expected, especially if the tumour has attained a large size. Most of the earlier writers, including Labbé and Remy, insist on the fact that it is possible to 'shell out' the growth over a considerable part of its extent, with section of little more than the pedicle. We are satisfied that in most cases something more than this is required, and that it is this practice which has been mainly responsible for the heavy recurrence rate reported by these authors. In the cases which we have seen only quite limited areas of apparent encapsulation have been present; over much larger parts of the surface the tumour has been inextricably blended with the fibres of its containing muscle or firmly adherent to surrounding fasciæ. The position has been accurately stated by Lecène and Delamare (1908): "We believe that most of these recurrences, if not all, are due to surgeons following classical (French) teaching and trying simply to enucleate. We now know that this may allow portions of fibromatous tissue to remain behind in the wall of the cavity, having infiltrated the muscle, and these cause the local recurrence." The practical conclusion which they draw is only to enucleate if and so far as the tumour separates with the greatest ease from surrounding parts; wherever there is adhesion, or, *a fortiori*, invasion of muscle, it is necessary to make a frank excision at some distance from the invaded tissues, whether muscles, aponeuroses of insertion, or peritoneum. They perform *resection-enucleation*.

When the tumour is small the gap remaining after excision is easily closed. In the case of larger tumours considerable difficulty may be experienced, and in a very few it may be necessary to pack the wound and allow it to granulate up from the bottom. This was the method adopted in *Case 6* of our personally observed series, where the tumour was firmly adherent both to the 11th and 12th ribs and to the crest of the ilium.

When the peritoneum is adherent to the tumour it is best to excise the adherent part along with the growth, and not to attempt to strip it off, as was originally the practice.

In our collected series of 66 cases 64 were treated by excision, one by electrolysis (Reed 1888, *Case 5*), and in one the operation was abandoned owing to the peritoneum having been accidentally opened (Reed 1888, *Case 1*). Two cases (Macfarlane 1832, *Case 2*, Reed 1888, *Case 4*) died of peritonitis following operation. In the case treated by electrolysis, considerable shrinkage of the tumour took place; in that in which the operation was abandoned the growth practically disappeared spontaneously. In the remaining cases the immediate results were good.

The later results are given in 20 cases, and in 4 of these, there was recurrence *in situ*. In Stone's (1909) first case the tumour slowly recurred and was

again excised twenty years after the first operation. In Lockwood's (1910) fourth case and in Senleeq and Chenot's (1911) case the recurrent tumours were each removed a year and ten months after the original operation. In Morison and Drummond's (1910) fourth case there was no evidence of recurrence two years after the second excision. The periods of freedom from recurrence in our collected series vary from a few months to several years. In eleven cases the period of observation was 1 year and over, and in three of these 5, 10, and 11 years respectively had elapsed at the time of publication.

In reporting a recent series of 31 cases of intramuscular fibroma, from the Mayo Clinic, 25 of which were situated in the abdominal wall, Nichols (1923) states that complete excision of the tumour resulted in permanent cure in all but one case. Four patients operated on elsewhere came to the Clinic with recurrences, and were apparently cured by operation and radium treatment. In three instances the tumour was not completely excised, and the patients are known to have recurrences. He concludes that complete and early excision of the tumour promises the most satisfactory results, but that radium and Röntgen rays are at least excellent palliative measures in inoperable cases. Of this latter mode of treatment we have no experience.

VI. SUMMARY AND CONCLUSIONS.

1. Fibroma of the abdominal wall is a simple fibrous-tissue tumour arising in the musculo-aponeurotic structures of the anterior abdominal wall, especially below the level of the umbilicus, and tending to infiltrate the muscle in which it lies.

2. It is met with in women who have borne children to the extent of 80 per cent of the reported cases, and it occasionally occurs in the scars of old hernial and other abdominal operation wounds. In other cases there is a history of local injury.

3. A traumatic theory of origin seems reasonable, and the physiological trauma of labour would appear to be of special importance. The infrequency of the condition points to the presence of some additional unknown factor, which, in the absence of more accurate knowledge, may be termed individual predisposition.

4. A peculiar change in the striped muscle fibres enclosed in the growth is described. It appears to be a process of de-differentiation, and results in the formation of multinucleated plasmodial masses resembling foreign body giant cells.

5. Fibromas of the abdominal wall are usually of slow growth in the earlier stages, but with the advent of mucoid or myxomatous change a rapid increase in size may occur.

6. They do not undergo metastasis nor do they endanger life, but there is no evidence that they ever disappear spontaneously.

7. Treatment should be early and complete removal, with resection of a margin of healthy tissue wherever muscle, fascia, or peritoneum is invaded by or adherent to the growth. Recurrence means incomplete resection and demands a more radical operation.

8. There is no evidence that sarcomatous metamorphosis ever occurs.

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CHRONIC INTUSSUSCEPTION: WITH REPORTS OF PREVIOUSLY UNPUBLISHED CASES.

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ALTHOUGH most surgeons can recall cases of chronic intussusception, it is a subject which is seldom discussed in surgical literature. By chronic is meant an intussusception which, throughout most and commonly all of its course, is unattended by the symptoms of acute intestinal obstruction. This broad interpretation may bring into the category cases which some would prefer to call subacute because of the severity of the symptoms apart from obstruction, but it serves the useful purpose of encompassing a group of cases which are quite distinct clinically from the acute type.

It has been customary also to divide chronic cases into various subdivisions depending on the age and cause, but the symptoms and signs in all varieties are much the same, and it seems preferable to consider the group as a whole. The notes of fourteen previously unpublished cases are appended. These occurred in Guy's Hospital between the years 1900 and 1924 (March) inclusive, and the writer was able to make observations on four of them. It will be seen that the complaint or its diagnosis has become much commoner during the last few years.

Causation.—On inquiring into the etiology of the condition one finds that a tumour of the gut wall is frequently present as the exciting factor. In this series of 14 cases it occurred in 6; it is much more common to find some such definite cause in adults. Eliot and Corsecaden,¹ who analysed 300 cases of all types of intussusception (acute and chronic) in adults, found the presence of a tumour in 100, 60 of these being benign and 40 malignant. The proportion of innocent to malignant in those now reported is 2 to 4. The above writers point out that intussusception occurring in the small intestine is rather more often due to an innocent tumour, whereas in the large intestine the tumour is more often malignant. Of the 6 cases here recorded which were due to tumours, 3 were in the small intestine and 3 in the large. In both sites 2 were malignant and 1 was innocent. Most tumours met with in the intestine have been mentioned in connection with chronic intussusception, and, when innocent, they are usually pedunculated or semi-pedunculated. The 2 innocent growths in this collection were submucous lipomata, while 3 of the malignant were carcinomata. The pathology of the remaining malignant case cannot be stated definitely.

Lesions other than tumours are sometimes the causal agents; thus, most types of intestinal ulceration, e.g., bacillary, typhoid, and tuberculous, have been found. The ulcer of the cæcum in *Case 8* was considered to be stereoral in origin, and secondary to a recent pregnancy. The starting point has

occasionally been an inverted Meckel's diverticulum, and, more rarely, a lesion of the outer coats of the intestine, e.g., tuberculous peritonitis. It is interesting to note that a pathological condition of the appendix is but seldom to be found as the cause of the trouble, although *Case 7* would appear to be an instance of such a cause.

Trauma is mentioned in the histories of some otherwise unexplained cases. Eliot and Corseaden found that, when present, it generally proved to be of the nature of a severe muscular exertion. *Case 9*, if the history can be taken as correct, appears to fall into this category.

When all such definite etiological factors have been excluded there remains a number of cases in which no cause can be discovered. Goodall² in 1910 made an interesting collection of 122 such cases of chronic primary intussusception in the adult. The absence of any demonstrable lesion is also a feature of the condition when it occurs in young children. Therefore, although one must admit the occurrence of these primary cases, yet some underlying pathology should always be suspected, especially in adults, and should only be excluded after the most thorough search at the time of operation. In this search it may even be necessary to open the bowel. *Case 1* was of interest in this connection: after reduction of the invagination the submucous lipoma as palpated through the intestinal walls felt very much like a mass of feces, although on further examination it became apparent that it could only be manipulated for a limited distance in either direction along the lumen.

Age.—Chronic intussusception may occur at any age, but certain groups of cases appear to favour particular periods of life. Those cases which are secondary to malignant tumours are found more often during the latter half of life, whereas those due to innocent tumours occur at any age, although they are uncommon before 10 years. Goodall found that the chronic primary intussusceptions of adults occurred most commonly between the ages of 20 and 40. Still³ draws attention to the fact that the condition can occur in very young children, and mentions four cases in which the ages were 13 months, 14 months, 23 months, and 3½ years. One infant in the present series was only 8 months.

Duration.—One of the most remarkable features of the complaint is the length of time it may last. It is difficult to realize that one part of the intestine may remain telescoped within the segment distal to it for many months or even longer without something very definite happening to make such an anatomical error obvious; but such a state of affairs is not uncommon in reported cases, and even in children the condition may last for many weeks. In most of the cases here reported the symptoms were sufficiently severe to cause the patients to seek advice at a somewhat earlier date. It is probable that in many cases of long duration the intussusception has not been present all the time, but has undergone spontaneous reduction for periods and then recurred. Such an explanation, however, is not applicable to all cases.

Position.—The position of the intussusception varies somewhat with the cause. When secondary to some form of growth it can occur anywhere in

the intestinal tract; the duodenum is not immune, neither is the rectum; but, as one would expect from its association with a tumour, it occurs most often in those parts of the intestine in which a tumour is likely to be found. Primary cases, whether in adults or young children, usually start in the ileo-cæcal angle; thus, in the cases mentioned by Goodall (adults), 70·3 per cent started in this region, the remaining number being more or less evenly divided between the small and large intestines (15·3 per cent and 13·5 per cent respectively). With regard to children, Still reports 3 ileo-cæcal and 1 ileo-colic; and out of the 5 cases of this type mentioned below, 3 were ileo-cæcal, 1 was ileo-colic, and the remaining one, although not definitely named, started in the same region.

Symptoms and Signs.—Although the symptoms and signs may vary in detail to some extent, most histories agree in certain outstanding features, and these, when grouped together, should lead to a correct diagnosis.

Onset.—This is sudden, and consists of an attack of acute griping pain in the abdomen which may be associated with vomiting. In *Case 2*, which is typical, the patient was suddenly taken ill while out walking and only managed to get home with great difficulty.

Pain.—Pain is one of the most characteristic features of the complaint. Patients will describe it variously as 'colicky', 'griping', 'acute spasms', or 'like labour pains'. It comes on in attacks which last for a few seconds or a few minutes, but may be longer. These spasms recur at intervals varying from minutes to hours, or rarely days, and in most cases the patient is absolutely free from all pain during these intervals. The pains are often increased by taking food, and when frequent keep the patient awake at night. As time goes on the length of the intervals tends to decrease, with the result that the patients become both worn out and pale.

Occasionally all symptoms disappear for long intervals, e.g., three years in *Case 9*, and twenty days in *Case 3*. The most likely explanation of these long periods of relief is that the invagination has undergone spontaneous reduction. There can be little doubt that this does happen, and is merely an extension of the well-recognized fact that intussusceptions, especially when chronic, are often found to vary markedly in length when examined from time to time during the course of the complaint. There are, too, certain instances in which complete spontaneous reduction has been proved. It is interesting that those working in the Children's Department of Guy's Hospital have reason to believe that the pains may subside for a time owing to fatigue of the gut. It would seem that this is the probable explanation of *Case 10*. In this instance there was a prolonged period of relief, although an enormous intussusception was present all the time.

Vomiting.—This is variable and may be absent altogether. When present it may occur only at the onset, or the patient may vomit occasionally throughout the course of the complaint. Even in children, although it is usually present at the onset, it is not necessarily prominent, but should it be present and green in colour it is a most important diagnostic sign.

Bowels.—Although the bowels frequently remain normal, yet some irregularity either in the direction of constipation or diarrhoea is commonly present.

Diarrhœa of a very objectionable nature is encountered when inflammatory changes are occurring in the gut walls (*Case 2*). Young children tend to constipation. Blood, if present at all, only occurs in traces. Slime, also, is not a constant feature, but may be marked when diarrhœa is troublesome.

Fasting.—This is usually very conspicuous, and is due to pain and loss of sleep, and to the fact that as the symptoms are often increased by food the patients prefer to eat as little as possible. It is most severe in children, and in them may lead to errors in diagnosis.

Tenesmus.—This is variable, but may be present to a troublesome extent.

Abdominal Examination.—The abdomen when examined during an interval of relief will be found to be flaccid, and very occasionally a swelling is visible in the region of the underlying intussusception. In the majority of cases a tumour is to be felt on palpation, and this tumour has been well described as 'sausage-shaped'. It is movable to some extent, and slightly tender on deep palpation. From time to time it may be felt to harden and relax, and if a number of examinations are made a variation in its length will frequently be noticed. In some instances it may even disappear altogether, and should this happen during the examination it will make the diagnosis almost a certainty, especially if the disappearance is accompanied by a gurgle. With regard to the palpability of the tumour it should be remembered that if placed high up under the costal margin it may be out of reach of the examining hand.

The number of attacks of pain provide ample opportunity for examination during one of them, and at such times the whole abdomen will be felt to become rigid; it is on these occasions, too, that the intussusception, if still discernible, is particularly liable to vary in its length. During the pains, visible peristalsis should be sought; it is not a constant sign, and is most likely to be seen in the wasted abdomen of a child. An undue emptiness in the right iliac fossa is to be demonstrated in some instances.

Rectal Examination.—This should always be made, as an intussusception not infrequently enters the rectum. It should be borne in mind, however, that it is possible for a growth to obscure an intussusception which it is dragging behind it. It is interesting to note that cases are recorded in which the intussusceptum has presented at the anus and has even protruded for some distance without obstruction supervening.

X-ray Examination.—As there may be but little interference to the passage of the contents of the bowel, it is unusual for an opaque meal to render much help, but a definite narrowing may be shown, and this is especially significant if it is present on re-examination. Schlink⁴ reports an interesting case in which the X rays definitely showed an intussusception; the bismuth had, in this instance, found its way between the receiving and returning layers and had remained there after the rest of the meal had passed along.

Differential Diagnosis.—If the characteristic signs and symptoms are present, the diagnosis ought not to be difficult provided the possibility be remembered. The conditions most likely to give trouble in the adult are: (1) Appendicitis with the formation of a tumour; (2) Carcinoma of the colon,

especially cæcum or ascending colon; (3) Ileocæcal tuberculosis; and (4) Distended gall-bladder.

Appendicitis not infrequently causes the formation of a rather sausage-shaped tumour, and if the case is seen after the more acute symptoms have subsided, some difficulty may arise. Such a tumour is usually more fixed than an intussusception, and there will be an absence of those variations in its size which have been described. The history, also, of the continuous character of the pain during the acute stage, and of the rise in temperature and pulse, will help in the diagnosis of appendicitis, and although it must be admitted that cases of this disease do occur in which the pain is spasmodic, it is rare for the spasms to occur with such frequent regularity as they do in intussusception.

Carcinoma of the cæcum and hypertrophic ileocæcal tuberculosis can be taken together, as the signs they present are much the same. In the early stages of these diseases pain and sudden onset, which are such characteristic features of chronic intussusception, are absent; but in the late stages visible peristalsis may be present, and this, together with the tumour and wasting, causes a very real difficulty. Again, there will be an absence of the variations in the tumour, and, when colicky pains occur, the other signs of obstruction will usually be present. In these difficult cases the history of the onset is very important.

A distended gall-bladder gave difficulty in an instance in which it was sausage-shaped—not pyriform—and extended vertically downwards to a lower level than the umbilicus. In such a case, however, the pain is more prolonged, different in character, and associated usually with a rise in temperature. In addition there will not be the frequent attacks of short duration lasting over a long period.

With regard to the differential diagnosis in children, Still found that at least three out of the four cases sent to him had been diagnosed as tuberculous peritonitis. The presence of a transverse swelling below the liver together with wasting led to the error; the tumour had been thought to be thickened and rolled up omentum. Here again a careful consideration of the pain, changes in the tumour, and suddenness or not of onset should prevent such a mistake.

On the Children's side of this Hospital it has been found that both chronic dyspepsia and follicular colitis present a difficulty when a tumour cannot be palpated, whereas when a palpable tumour is present purpura may cause trouble in diagnosis. In chronic dyspepsia the wasting and the pains brought about by fermentation, together with the frequent presence of visible peristalsis (due to the thin abdominal wall), are the causes of the resemblance, but the sudden onset will be absent, and vomiting, although it may not be a prominent symptom in chronic intussusception, does, if green, favour that diagnosis, as such vomiting is rare except in the last stages of chronic dyspepsia. The stools in dyspepsia, although they frequently contain large quantities of mucus, are pasty in character. In chronic follicular colitis the blood and slime may recall intussusception, but the former disease is a sequel of an acute primary attack of the same complaint—or follows insidiously on a simple dyspeptic diarrhoea, and there will usually be some degree of temperature

present. The diagnosis also depends largely upon frequent and careful examination of the abdomen.

In Henoch's purpura the hæmorrhage into the intestine may cause a tumour to be palpable through the abdominal wall: in *Case 13* it was difficult to decide whether the lump was due to such a cause or to an intussusception. The flea-bites which were present only helped to increase the difficulty as the examination was made in artificial light and they resembled markedly the petechiæ of purpura: but the fact that the spots covered the trunk and extremities to an equal degree favoured the former diagnosis. as in purpura they are more numerous on the extremities than on the trunk. In purpura also the swelling and pain in the joints, together with hæmorrhages from other mucous membranes, help in the diagnosis, but it is to be remembered that such signs may be slight or absent altogether.

Discussion.—An inquiry into the factors which determine whether an intussusception is going to be acute or chronic brings out many interesting facts which are apt to be neglected in the text-books. The congestion, inflammatory œdema, and later, if left, ulceration and gangrene, which are the characteristics of the acute type, obviously have their origin in an interference with the vascular supply of the intussusceptum. Obstruction is the clinical manifestation of this interference, and is the result both of the changes in the gut wall and of the occlusion of the lumen. Granting, then, that the determining factor is the presence or not of some obstruction to the vascular supply of the invaginated portion, upon what does it depend?

Waugh⁵ reports three cases of chronic intussusception in children in all of whom it was found that the large intestine had retained its primitive mesocolon.* In addition to this there were other evidences of failure to undergo complete development; the appendix in each case was large, in none had the mesocolon of the transverse portion of the gut fused with the layers of the omentum, in one a Meckel's diverticulum was found, and in another a congenital hernial sac. It is clear that the persistence of a mesentery to the colon will permit of the invagination proceeding to a greater distance without dragging on the vessels, and, further, it will allow the ensheathing layer to be taken up easily into the returning layer as the intussusception moves along, with the result that the neck of the intussusception will not remain as a rigid point around which the mesentery of the invagination will kink.

The case with which the ensheathing layer can be taken up or unravelled in chronic cases is well displayed at operation, and although the presence of a primitive mesocolon is not always to be found, yet it can be shown usually that the so-called fixed parts of the colon are unduly mobile. Fitzwilliams⁶ draws attention to the fact that after reduction it can frequently be demonstrated that a mesentery has been formed by a process of 'borrowing'

* In this interesting paper Waugh draws attention to a peculiar symptom which existed in all three cases, viz., the presence of paroxysmal attacks of pain referred to the end of the penis and to the suprapubic region.

from the parietal peritoneum, and in the operation of colectomy Sir Arbuthnot Lane has shown that the same result can be brought about by a little traction on the fixed parts of the colon. The amount of mesentery, however, which is available is much greater in some individuals than in others; it is probably the length of the mesentery, or the ease with which it can be formed or increased in length, that determines whether or not the intussusception will be chronic.

It is also possible that in addition to the above factors the tone of the muscles of the ensheathing layer is of importance, inasmuch as spasm of these muscles may interfere with the flow of the blood in the mesentery of the intussusceptum.

Treatment.—The treatment of this complaint must obviously fall to the lot of the surgeon, and although not a surgical emergency, there should be no delay in operating once a diagnosis is made. Drastic purgatives should not be given lest the case be converted into one of acute intussusception (*Case 1*).

Reduction is in most cases easy. Some degree of œdema of the gut walls is found usually, but not always; and if the invagination is of long standing, adhesions between the serous surfaces may have occurred. These latter, although making reduction more difficult, do not necessarily make it impossible. When a growth is found after reduction it is generally possible to deal with it at once, and removal in these cases has been followed by very good results. Should adhesions prevent reduction, then excision of the intussusception, or of the intussusceptum, or a short-circuiting operation, are the courses available. In deciding which should be done, due consideration should be given to the possibility of an underlying pathological lesion. In the adult, conditions permitting, excision of the whole intussusception is preferable on account of the frequency with which some form of growth is found, whereas in the infant the object is to interfere as little as possible, and the question of what should be done can only be decided after careful consideration in each individual case.

It is usually unnecessary to perform any operation for the prevention of recurrence, but some such procedure may be advisable in cases where there is a definite history of recurrent attacks. In such circumstances plying of the mesentery, fixation of the appendix to the abdominal wall (Alexander?), or colopexy can be used; but again it is necessary to exclude beforehand the presence of a small pedunculated tumour within the lumen of the bowel.

An interesting question occasionally arises. A case may have been seen and diagnosed as one of chronic intussusception, but before operation all signs and symptoms may have disappeared. Is operation justified? If the patient is an adult and there is nothing in his general condition which would contra-indicate it, there can be little doubt that, bearing in mind the strong possibility of some tumour being present, the wise and safest course would be to do a laparotomy. *Case 3* is a good example of an intussusception leading to the discovery and excision of an early carcinoma. In the case of an infant there would be no such definite reason for operating after spontaneous reduction had occurred.

REPORT OF CASES.

Group I.—Due to Innocent Tumours.

Case 1.—A. E. G., male, age 7. Admitted Sept. 7 1923 for abdominal pain.

HISTORY.—For the fortnight previous to admission the patient had suffered from recurrent attacks of colicky abdominal pain, of which the onset was sudden and the duration a few seconds only, with intervals of complete relief. They numbered about six in the twenty-four hours, and sometimes occurred while he was playing in the street. He would, at these times, run to his mother, only to return to play again immediately the spasm was over. Bowels were opened normally every day. The pains increased in severity during the three days before admission. He was given a purge twenty-four hours before admission, and since that time the pain had been continuous and he had passed no faecal matter. Some blood and slime were passed shortly before admission.

EXAMINATION.—Child in severe abdominal pain. Abdomen held somewhat rigidly. A sausage-shaped tumour could be seen pushing the anterior abdominal wall forwards in the upper left quadrant. On palpation this seemed to correspond to the left half of the transverse colon and descending colon. *Diagnosis:* Super-vention of acute on chronic intussusception.

OPERATION, Sept. 7.—A certain amount of free fluid present in peritoneal cavity. An intussusception was found involving the terminal half of the transverse colon, descending colon, and the upper part of the iliac colon. Reduction easily performed. There was no congestion and but little œdema. On further examination a soft mass about the size of a walnut could be felt in that part of the transverse colon which had formed the apex of the intussusception. Although somewhat like a faecal concretion, it was found that it could only be manipulated a very limited distance in either direction along the colon. On removal it proved to be a semi-pedunculated submucous lipoma growing from the posterior wall of the colon. The child made good progress and was discharged on Sept. 24.

It is interesting that acute obstruction appeared to be determined by the use of a purgative.

Case 2.—E. B., female, age 53. Admitted Jan. 29, 1923, for abdominal pain.

HISTORY.—Good health except for rheumatic fever between the ages of 19 and 25. She has always been anæmic. Eleven days before admission the patient, when out shopping, was seized with acute abdominal pain originating in the right iliac fossa and spreading over the whole abdomen. The pain was so severe that the patient only managed to get home by supporting herself against the wall. Since then the attacks have recurred, usually at five-minute intervals, but occasionally she has been free for as much as half an hour. The attacks last about two minutes, and during the interval there is complete relief. No vomiting. Bowels open, and the patient describes the motions as slimy and of a particularly objectionable odour. For five days previous to admission she has refrained from eating solid food as the pains were made worse thereby.

EXAMINATION.—Patient well covered. Abdomen moves well. On palpation a large sausage-shaped tumour can be felt in the right iliac fossa; it is firm in consistency, with its long axis in the vertical plane. It can be moved laterally to some extent, but not in the vertical direction. Some tenderness on deep pressure. *Diagnosis:* Chronic intussusception.

OPERATION, Jan. 30.—This disclosed a considerable amount of clear fluid in the peritoneal cavity. A double intussusception was found. The outer one reduced easily and its apex was formed by the ileocaecal valve. There was such marked congestion and œdema of the inner intussusception that complete reduction was impossible. It consisted of the terminal few inches of the ileum. Resection was performed. On examining the resected portion a sloughing pedunculated submucous tumour about the size of a marble was found, which on microscopical examination

proved to be a "necrotic and suppurating lipoma". The patient did well and was discharged on Feb. 24.

This patient was admitted a year later for adhesions, and a short length of the terminal ileum was short-circuited. Discharged fit.

Group II.—Due to Malignant Tumours.

Case 3.—R. C., male, age 43. Admitted Aug. 27, 1923, for paroxysmal attacks of abdominal pain.

HISTORY.—On Aug. 3, he was suddenly doubled up with acute abdominal pain while at work. The attack lasted about four minutes and then completely passed away. He had several similar attacks on the same day, with intervals of complete freedom from pain. The following day he suffered from diarrhoea. On Aug. 23 the pain commenced again and occurred in attacks similar to those before. After each paroxysm he was seized with a painless desire to defæcate, but only passed small quantities of fluid per rectum. He noticed neither blood nor slime. The pains were not influenced by meals. He vomited the next morning. The pains again subsided somewhat.

EXAMINATION.—An indefinite swelling could be palpated on the left side of the abdomen, but a little later this had disappeared, and the pains, which had become less, eventually subsided. He had relief for a number of days, but the attacks started again on Sept. 8. These now lasted about five minutes, with intervals of only a few seconds. Diarrhoea again became marked, and now specks of blood and small quantities of slime were noticed. The tumour also became palpable again in the region of the descending and pelvic colons. The pain kept him awake at night. Occasional vomiting. *Diagnosis:* Chronic intussusception.

OPERATION, Sept. 11.—Immediately before removal to the theatre the lump was easily felt in the left iliac fossa, but when examined again under the anæsthetic it had decreased much in size, and could only be palpated in the region of the upper part of the descending colon. On opening the abdomen an intussusception was found, involving the splenic flexure and descending colon. It was easily reduced, and when this had been done the apex was found to be formed by a small carcinoma of the splenic flexure. Resection performed. Discharged fit.

Case 4.—A. B., female, age 48. Admitted March 4, 1923, for abdominal pain.

HISTORY.—Indigestion for the last two years. Appendicectomy three or four months before admission. This had relieved the pain in the right iliac fossa, but patient occasionally had attacks of a dull aching pain in the epigastrium at night. Three weeks previous to admission patient experienced attacks of colicky pain and marked vomiting. The attacks lasted about ten minutes and were followed by intervals of complete relief for two or three hours. The pain was relieved somewhat by vomiting, but disturbed the patient's sleep. These symptoms continued for about ten days and then she had a week's relief before they started again. She was constipated during the attacks. No blood or slime.

EXAMINATION.—Patient is pale and has lost a great deal of weight. No mention of physical signs except the absence of tenderness. X-ray examination showed the stomach and duodenum greatly dilated.

OPERATION, April 5.—An intussusception was found in the jejunum about 8 inches from the duodenojejunal flexure. It was difficult to reduce, but when reduction was completed the apex was found to be formed by a growth. Resection performed. Patient discharged fit. Section of growth showed "colloid columnar-celled carcinoma of jejunum".

When examined a year later this patient was looking particularly well.

Case 5.—H. T., male, age 39. Admitted Aug. 21, 1905.

HISTORY.—Eleven weeks ago patient had an attack of abdominal pain and bleeding from the bowel. The attack lasted twenty-four hours. Three weeks later a similar attack occurred, but the pains were severer. Since that time patient

has suffered from attacks of abdominal pain about three times a week. The pains are accompanied by tenesmus.

EXAMINATION.—After admission the patient had periods of abdominal pain, and on the fourth day a lump was palpable in the left hypochondrium. The lump varied in length at subsequent examinations, and mucus and blood were passed when the attacks were severest. *Diagnosis:* Intussusception probably produced by growth.

OPERATION, Aug. 30.—Intussusception of descending colon found, caused by a growth which incompletely surrounded the lumen of the gut. Resection performed and an end-to-end anastomosis made. On discharge patient had a faecal fistula.

The fact that an end-to-end anastomosis was performed in 1905 is of interest. When examined ten years later this patient was well and the fistula was healed.

Case 6.—H. B., male, age 40. Admitted March 18, 1906, for pain in the abdomen.

HISTORY.—Healthy previous history. Abdominal pain started 'last Saturday week'. It is situated in the hypogastrium and occurs in attacks which 'grip' him. The attacks come on every ten minutes and keep him awake at night. He vomits occasionally. There is no rectal pain.

EXAMINATION.—A hard mass is to be felt in the region of the umbilicus. It is very tender. It can be moved up and down, but very little laterally.

OPERATION, March 22.—Intussusception of lower end of ileum caused by growth. Resection. Patient died March 27.

In this case there is some doubt as to whether the tumour was a carcinoma or sarcoma.

Group III.—Due to Appendicitis.

Case 7.—J. S., male, age 12. Admitted Aug. 6, 1905, for abdominal pain and vomiting.

HISTORY.—A fortnight's history of loss of appetite, vomiting, and abdominal pain; the vomiting became a very marked feature.

EXAMINATION.—Patient is thin and pale. No pain. Lump palpable in the right iliac fossa. After a few days this lump appeared to become somewhat smaller in size, but to ascend in position. It was not tender. Bowels open daily while in hospital.

OPERATION, Aug. 13.—Intussusception found. It consisted of caecum, appendix, and about 1½ in. of ileum. The appendix, 4 in. in length and about 2 in. in circumference, was found in the foetal position: its distal end contained fluid, the lumen being obliterated proximally. Intussusception was reduced—and appendicectomy performed. The stump was not invaginated. Discharged fit.

Group IV.—Due to Innocent Ulceration.

Case 8.—E. D., female, age 39. Admitted Aug. 3, 1920, with abdominal pain.

HISTORY.—Patient's youngest child was born four months previously. Three days before admission patient suddenly experienced cramp in the abdomen. These pains she likened to the 'bearing-down' pains of childbirth. They occurred at half-hourly intervals and there was complete relief between the attacks. The pains interfered with sleep and were increased by food. Vomited at onset. Diarrhoea present, the stools containing blood.

EXAMINATION.—Patient is an anæmic woman. A tender sausage-shaped tumour palpable in the region of the upper part of the ascending colon and the first part of the transverse colon. *Diagnosis:* Chronic intussusception.

OPERATION, Aug. 6.—No tumour could be demonstrated, but the caecum and appendix were oedematous and appeared as if they had been invaginated. The pathological condition of the caecum was doubtful and it was decided to remove it. An anastomosis was made between the ileum and the upper part of the ascending

colon. On examination of the *cæcum* after removal, ulceration of the mucous membrane was found. The clinical microscopist reported "inflammatory ulceration of the *cæcum* and appendix".

This ulceration was considered to be secondary to the recent pregnancy. Three years later this patient was operated upon for obstruction caused by a band. She made a successful recovery.

Group V.—Due to Sudden Exertion.

Case 9.—D. Y., male, age 28. Admitted Aug. 7, 1920, with abdominal pain.

HISTORY.—Healthy previous history. In the summer of 1917 the patient was carrying a gas cylinder when his right foot slipped into a shell hole. He was seized with abdominal pain which lasted, in attacks, for two or three days. There was no vomiting. Bowels normal. He reported to the medical officer and was given a 'No. 9'. The duration of the attacks was about ten minutes, and the intervals between them about three hours. The pains would travel all over the abdomen and then settle in the region of the umbilicus. After this occasion he was free from pain until about a month before admission, i.e., for an interval of three years. On this second occasion the pain started suddenly. It was not very severe, and the attacks would last about two minutes, with five-minute intervals. During the intervals he was entirely free. The symptoms gradually subsided, but recurred occasionally in griping spasms chiefly in the region of the umbilicus and right iliac fossa. Bowels normal. Five days before admission the pains became more severe and kept him awake during the night. He vomited six times. On the following day he was better, but he continued to have spasms at intervals until admission.

EXAMINATION.—An ill-defined swelling could be palpated to the right of the umbilicus.

OPERATION, Aug. 7.—A chronic intussusception was found. It involved the *cæcum*, appendix, and ascending colon. Reduced. Discharged Aug. 21.

This patient was quite fit when seen three and a half years later.

Group VI.—Primary Cases in the Adult.

Case 10.—E. R., female, age 34. Admitted Aug. 18, 1913.

HISTORY.—About six weeks ago patient commenced having griping pains in the abdomen. The pains came on in attacks which lasted about ten minutes and occurred three or four times a day at the beginning, becoming more frequent later. In the intervals the patient was free from all pain. The pains were made worse by food and kept patient awake at night. Bowels constipated and enemata required. There was some blood in the *fæces* at the commencement.

After admission the bowels became more or less regular, and 'lumps' could be felt on the right side of the abdomen. A laparotomy was performed, but the patient's condition caused grave anxiety and the abdomen had to be closed before the exact state of affairs had been disclosed. Nevertheless a tumefaction of the colon was noticed in the region of the hepatic flexure, transverse colon, and descending colon. After this operation the pain, although it still occurred, was not so persistent, and she would have periods of relief for about three days, followed by similar attacks. The bowels were fairly regular. For a week before the second operation, which was six weeks later, the patient had no pain at all. At the second operation an intussusception was found, the ascending colon, *cæcum*, appendix, and lower part of ileum being invaginated into the transverse colon. The parts were rather inflamed and the appendix was adherent. Reduction was performed and the appendix removed.

When seen ten years later the patient had had no recurrence of the symptoms.

Group VII.—Primary Cases in Children.

Case 11.—J. B., male, age 8 months. Admitted Sept. 18, 1922, for vomiting and diarrhoea.

HISTORY.—Breast-fed up to three months ago. Since then cow's milk during the day while mother was at work. Constipated since birth. A month previous to admission the baby commenced to vomit all his feeds, and a week later had diarrhoea in which mucus and streaks of blood were present. The diarrhoea has alternated with constipation and the vomiting has continued to be marked. The baby has wasted considerably.

EXAMINATION.—Weight 6.000 grm. Extremely pale and drowsy. Abdomen generally tender, but no tumour palpable. Abdominal wall very thin. Sept. 20. Patient has vomited after two feeds but has kept down the others. Stools loose, but no visible blood or mucus. Sept. 21. Small intestine peristalsis visible. Elongated, vertical swelling felt under right costal margin. Nothing felt per rectum. Opaque meal arrested in small intestine. *Diagnosis:* Chronic intussusception?

OPERATION, Sept. 22.—An ileocolic intussusception was found. This was reduced from about one foot to three inches. Adhesions prevented further reduction of the remaining portion in the ileum. Ileocolostomy performed. Death a few hours later.

Case 12.—K. S., male, age 11 months. Admitted March 28, 1924.

HISTORY.—Eight days before admission the baby was suddenly taken ill with violent pains in the abdomen. He vomited frequently and "passed a night made horrible by his dramatic attacks". The pains occurred every ten to twenty minutes, and continued until the day of admission. For the first few days the baby was constipated, but then passed an offensive motion streaked with blood and slime. The bowels were then opened daily for the next three days: blood and slime were noticed in the stools. For two days before admission the bowels had not worked except for the frequent passage of blood and slime. The child vomited throughout the complaint, the vomit on many occasions being green in colour. The pains woke the child at night.

EXAMINATION.—Child wasted. Horseshoe swelling present under umbilicus.

OPERATION, March 28.—Ileocaecal intussusception found extending to within one inch of the splenic flexure. A short re-intussusception of the ensheathing layer had occurred half-way along the transverse colon. There was œdema of the intussusceptum, but no inflammation. Intussusception reduced. Discharged fit.

This case had become acute forty-eight hours before admission.

Case 13.—A. S., female, age 9. Admitted Feb. 2, 1923, for abdominal pain.

HISTORY.—For the fortnight previous to admission the patient had been suffering from attacks of abdominal pain—most violent at night. The attacks would last about ten minutes, and occurred five or six times during the day, but were more frequent during the night. Patient had complete relief during the intervals. No vomiting. Bowels regular. No blood, but a little slime. The attacks became more frequent and resulted in the child becoming exhausted.

EXAMINATION.—Visible and palpable swelling just to right of epigastrium. Visible peristalsis. Attacks brought on by examination of abdomen, and during the attacks the peristalsis was most marked. Stools normal. The patient's trunk and arms were covered with flea-bites.

OPERATION, Feb. 2.—Ileocaecal intussusception found. Reduced. Appendicectomy performed. Discharged fit. The differential diagnosis is an interesting feature in this case, and is dealt with in another part of the paper.

Case 14.—M. T., female, age 5. Admitted March 7, 1918, for pain in abdomen.

HISTORY.—Six weeks ago patient had pain in her abdomen. Her bowels were opened normally, but she experienced pain on defæcation. She was given medicine which relieved the pain. A week ago the pain commenced again, but was worse than before and caused the child to double herself up. There was a desire to defæcate when the pain started. Patient is losing weight and has a craving for water.

EXAMINATION.—Tumour in right iliac region. Pain on palpating abdomen.

OPERATION, Mar. 8.—Ileum invaginated into ascending colon. Some adhesions. Reduced and appendicectomy performed. Discharged fit.

Case 15.—M. O'C., female, age 3. Admitted Oct. 21, 1913, for abdominal pain.

HISTORY.—Duration over forty-eight hours. Abdominal pain with intervals of rest. Sick several times, the vomit being green. Motions normal. No blood.

EXAMINATION.—Tumour in region of transverse colon. Occasional visible peristalsis. A prominence is occasionally visible in the position of the tumour.

OPERATION, Oct. 21.—Ileocaecal intussusception found. No evidence of inflammatory changes was present, and reduction proved easy. Discharged fit.

This patient had had a similar attack about a year previously. The vomit was green on this occasion also. The attack passed off in a day or two. This case is reported by Mr. W. H. Ogilvie in the *Guy's Hospital Gazette*, Nov. 22, 1913, but is included to complete the series.

I beg to thank the members of the Staff for their kind permission to publish these cases, and Dr. A. A. Osman for his help in connection with the part of this article which deals with children.

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*SHORT NOTES OF
RARE OR OBSCURE CASES*

**A CASE OF NON-ROTATION OF MID-GUT LOOP LEADING
TO VOLVULUS OF THE CÆCUM.**

BY MICHAEL W. BULMAN, NORWICH.

It is uncommon to meet cases in which urgent abdominal symptoms are the result of gross malposition of the viscera. In the case about to be reported, the symptoms were clearly those of intestinal obstruction, the cause of which could not be diagnosed before operation. It was possible at the post-mortem examination to demonstrate the complete extent of the abnormality, and as reported cases of this condition are few, as full a record as practicable of this case has been made.

Mr. B., age 76, was admitted to the Norfolk and Norwich Hospital on May 18, 1924.

HISTORY.—As far as can be ascertained the patient had been healthy all his life, and had suffered from no abdominal trouble till about three years ago. He then began to complain that after stooping, as for instance when doing up his boots, he would feel something slip out in the right lower abdomen, and this he described as his 'rib slipping out'. When this happened he would lean back in his chair and press the right side of the lower abdomen upwards and backwards as though to lift something into place. Two days before admission to hospital he was wakened at 4 a.m. with severe abdominal pain, and vomited once. The pain was referred to the umbilicus and the left hypochondrium, and was colicky in type. He was unable to pass wind downwards, but was constantly belching wind, and this act caused pain in the left hypochondrium. On the day of his admission he again vomited; Dr. Sturdee, of Walsingham, was called in, and at once sent him to hospital.

EXAMINATION.—Pulse, 104; temperature, 97.8. The tongue was dry and furred, the skin dry and earthy, and the eyes were sunken. The abdomen was greatly distended and was tympanitic all over, the tympanites being particularly marked in the left hypochondriac region. Peristalsis was not seen, and no tumour was made out. There was a small right femoral hernia, but this appeared not to be strangulated. Nothing abnormal was detected per rectum.

OPERATION.—In spite of the fact that the femoral hernia was thought not to be strangulated, it was deemed advisable first to explore this. The sac was found to contain only a small quantity of cloudy, straw-coloured fluid; the sac was removed and the incision closed. The abdomen was then opened by a right paramedian incision, and distended coils of small intestine immediately presented in the wound. On passing the hand down into the right

iliac fossa, the cæcum could be felt; but after displacing the small intestine to the right, the cæcum was found under the left costal margin, black in colour, completely gangrenous, and distended to a capacity of about $1\frac{1}{2}$ pints. After puncturing it, it was possible to draw the cæcum down into the right iliac fossa, and it was now seen to be twisted one turn in an anti-clockwise direction round a narrow pedicle situated in the right iliac fossa; the ileocaecal artery was thrombosed. The ascending colon was found to be passing up to the left of the mesentery of the small intestine, while the ileum terminated in the right side of the cæcum. As the condition of the patient was urgent, the cæcum was rapidly resected, tubes being passed into the cut ends of the gut and brought out through the lower part of the incision. The patient died a few hours after the operation.

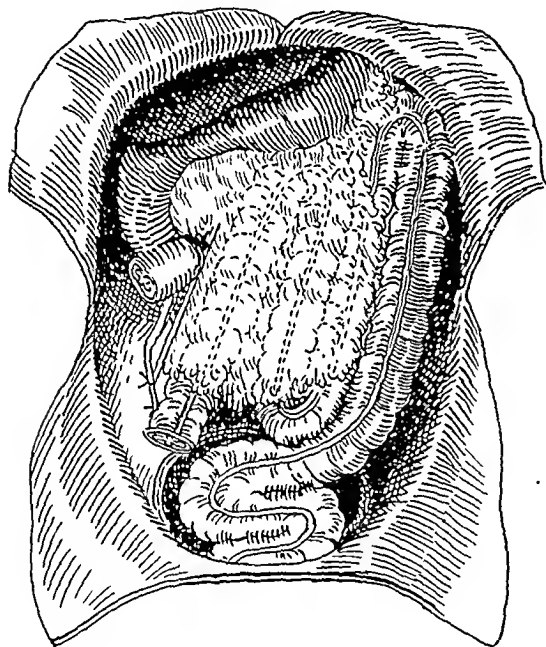


FIG. 272.—Diagram showing the position of the colon and of the duodenojejunal flexure. The small intestine has been omitted for the sake of clearness. The short mesentery of the small intestine is shown extending down from the duodenojejunal flexure, and the site of the pedicle on which the cæcum had twisted is indicated by the ligatures. The omentum is seen covering in the ascending colon, the proximal part of the transverse colon, and to some extent the distal part of the transverse colon as well.

POST-MORTEM.—Post-mortem examination showed that, while the splenic flexure was situated in its normal position, the ascending colon passed from the right iliac fossa upwards and to the left, the hepatic flexure being in contact with the splenic flexure under cover of the greater curvature of the stomach. The transverse colon formed a loop extending down to the pelvic brim between the ascending and descending colon. The sigmoid colon was abnormally long, being composed of two loops which were bound to each other and to the pelvic wall by peritoneal adhesions. The great omentum, passing down from the greater curvature of the stomach, was attached to what represented the upper border of the transverse colon, and from here stretched across the proximal loop of the transverse colon and the ascending colon, to be attached to the root of the mesentery of the small intestine.

The peritoneal relationships of the colon were difficult to make out. The

adjoining edges of the colon were covered by broad, sheet-like peritoneal adhesions, and after dividing these, one appeared to pass straight through into retroperitoneal cellular tissue. There was no definite transverse mesocolon, but this appeared to be represented by a sheet of condensed cellular tissue which allowed the colon to be drawn about three inches forward from the posterior abdominal wall, and which carried the blood-vessels and lymphatics. The arteries to the colon were distorted, but were normally distributed: the branches of the superior mesenteric artery were so short as to prevent replacement of the hepatic flexure in its normal position. The superior mesenteric vein was normally placed, but was joined about one inch below the pancreas by the inferior mesenteric vein. The duodenum was normally fixed by peritoneum: but the duodenojejunal flexure was situated to the right of the mid-line opposite the third lumbar vertebra, and from this point a short mesentery for the small intestine passed downwards for about two inches into the right iliac fossa. (*Fig. 272.*)

This case is clearly one of non-rotation of the mid-gut loop during the second stage of intestinal rotation, and the embryology of the condition has been so clearly stated by Dott¹ that it needs no repetition.

From the position of the pedicle of the twisted cæcum as seen at operation it would appear that the cæcum normally lay in the right iliac fossa, possibly being pushed down into the pelvis when the intra-abdominal pressure was raised, thus giving rise to the feeling of something slipping in the lower abdomen. The position of the cæcum under the left costal margin at the time of operation is probably to be explained on the assumption that, as it became distended after torsion had occurred, it tended to follow the line of least resistance, being guided upwards and to the left by the mesentery of the small intestine. With the patient lying in bed there would be no great tendency for it to fall into the pelvis, as might occur when he stooped.

In a series of 48 cases reported by Dott (*loc. cit.*), only 13 gave rise to symptoms, and of these 13 cases, only 1 occurred in old age. Volvulus of the ileocecal segment, such as was observed in this case, would seem to be the typical cause of symptoms in old age, and is probably the result of over-distention of the cæcum.

I have been unable to find any reference to a similar unusual termination of the inferior mesenteric vein in the superior mesenteric vein, a full inch below the formation of the portal vein in this case; but Cunningham² states that "it occasionally terminates in the angle of union between the splenic and superior mesenteric veins".

I am indebted to Dr. Sturdee, of Walsingham, for much information as to the past history of the case.

REFERENCES.

- ¹ DOTT, NORMAN N., *Brit. Jour. Surg.*, 1923, xi, 251.
² CUNNINGHAM, *Text-book of Anatomy*, 4th ed., 993.

SARCOMA OF METATARSUS IN AN INFANT.

BY A. H. SOUTHAM, MANCHESTER.

SARCOMA arising from the bones of the hand or foot appears to be a disease of exceptional occurrence. Bland-Sutton states that owing to the rarity of the condition, little is known of its clinical course. The following case in a child, who was recently under my care, appears, therefore worthy of record.

The patient, a girl, when two months old, was found to have a small tumour growing from the periosteum of the metatarsal bone of the left great toe. The growth was removed locally by her doctor, but rapidly recurred. When seen two months later there was a large fungating growth, which bled easily, involving practically the whole dorsal aspect of the foot (*Fig. 273*). A small piece was removed for microscopical examination, and Dr. A. Sellars reported that it was a mixed-celled sarcoma.

In January, 1924, the child was admitted to the Royal Manchester Children's Hospital. No secondary deposits were discovered in the lungs on X-ray or clinical examination, and at the request of the parents the limb was amputated through the middle of the thigh on Jan. 30.

The child made a satisfactory recovery after the operation and went home, but died about a month later from what was considered to be pneumonia. No post-mortem examination was obtainable, but it appears not unlikely that death was due to secondary growth in the lungs. Examination of the tumour showed it arose from the metatarsus, and had the structure of a sarcoma of the mixed-celled type.

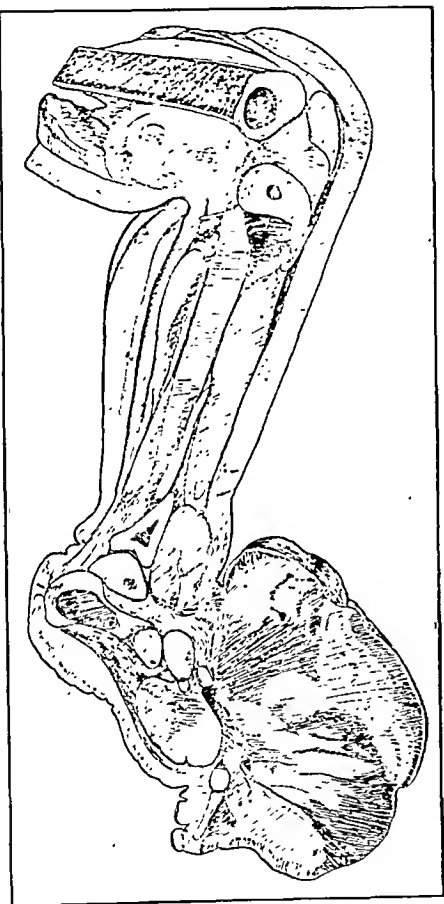


FIG. 273.—Sarcoma of the metatarsus in an infant.

It appears from the scanty information available that these tumours are intensely malignant, and, as in other sarcomata of infants, recurrence may be expected at an early date. Present-day methods of treatment seem to have little influence on the high mortality. A course of Coley's fluid might be useful, and it was hoped to have tried it in this case if the child had survived.

CASE OF EPITHELIOMA OF THE PENIS.

BY E. W. JOHNSON, LIVERPOOL.

THIS case seems to be worth recording, because it presents certain interesting features, and also because pictures of such marked cases are not usually seen in the common text-books.

The patient was 35 years old. He gave a history of syphilis five years previously, for which he said he received treatment and was circumcised. His own doctor confirmed this statement. The duration of the present condition was six months. He thought it was a recurrence of his syphilitic trouble, and did not seek medical advice until the growth attained the size seen in the photograph (Fig. 274). The Wassermann reaction of the blood was positive.



FIG. 274.—Epithelioma of the penis.

The typical 'cauliflower' appearance, invasion of the scrotum, and the involvement of the inguinal glands, are well shown in the figure. Microscopical examination of a portion of the growth revealed that it was a typical epithelioma (Professor J. M. Beattie).

The interesting features of the case are:—

1. The age of the patient. Epithelioma of the penis is rarely present before the age of 40.¹

2. The history of syphilis and the positive Wassermann reaction.

3. The fact that he had been circumcised. Rose and Carless say that epithelioma of the penis rarely arises except in patients who are subjects of congenital phimosis or possess long foreskins, and hence it is stated that the disease is unknown amongst the Jews.²

REFERENCES.

- ¹ *Index of Differential Diagnosis of Main Symptoms*, J. Wright & Sons Ltd., 3rd ed., 619.
² *Manual of Surgery*, Baillière, 9th ed., 1273.

A CASE OF FIBROSARCOMA OF THE ORBIT WITH MULTIPLE SECONDARY DEPOSITS.

BY CECIL P. G. WAKELEY, LONDON.

FIBROSARCOMATA are tumours of unusual interest from the fact that it is so difficult to correlate the clinical course with the histological findings. At times a tumour with definite histological appearances of malignancy behaves like an innocent tumour, and its removal effects a permanent cure. In other cases tumours with an identical histological picture grow and metastasize with great rapidity. The following case is of interest because of the large number of secondary deposits which were found.

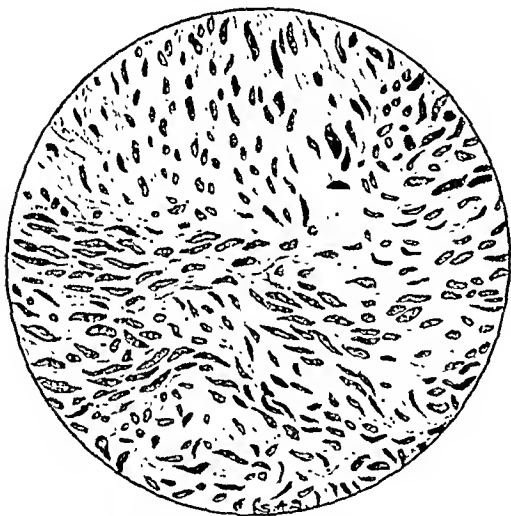


FIG. 275.—High-power view of tumour removed from the orbit. Typical fibrosarcoma.

George P., age 61, a waiter in an hotel, first noticed some pain in his left eye during February, 1923, and also found that his sight was very poor in that eye. A month later he came to King's College Hospital. On examination it was seen that the left eye was displaced upwards and inwards. There was also proptosis of this eye, so that the anterior part of the cornea lay 8 mm. in front of a line drawn from the prominence of the eyebrow to the malar eminence. There was lachrymation from the left eye, and oedema in both lower lids. There was some local tenderness, but no abnormality

of the margins of the orbit was palpable. Vision was: R.V. = Able to read; L.V. = Perception of light only. There was well-marked papilloedema in the left fundus. Nothing abnormal was detected in the nose or nasal sinuses. On May 17, Mr. L. V. Cargill completely removed the contents of the left orbit. A hard round swelling of the size of an olive was found, attached by a pedicle to the periosteum on the outer side of the floor of the orbit at the external canthus; it was completely free from all other structures. The tumour was removed, together with the adherent periosteum. Healing took place rapidly.

The tumour proved to be a fibrosarcoma (Fig. 275). Twelve days after operation 100 mgrm. of radium were introduced into the left orbit for twelve hours. X-ray therapy was commenced in June. In July the lower part of the left orbital cavity was skin-grafted; the grafts, which were taken from the leg, were all successful, and the patient was discharged ten days after this operation.

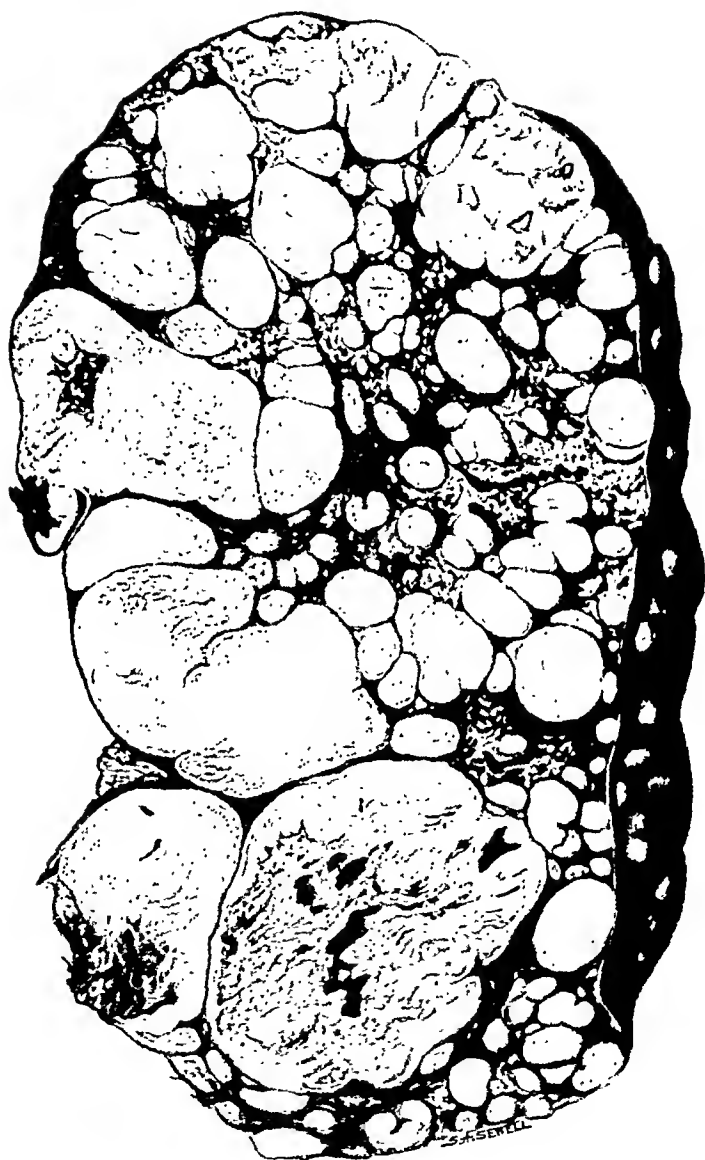


FIG. 276.—Section through the liver, showing the numerous secondary deposits.

In September, 1923, the patient was readmitted to hospital complaining of 'indigestion', which was worse after food. He stated that since his last operation nine weeks previously he suffered much discomfort from time to time after meals. He also stated that he suffered from shortness of breath on any exertion; he never had any actual pain or nausea or vomiting. He had never been jaundiced. He had not lost any weight since his last stay in hospital.

On examination there were no abnormal physical signs in the thorax. The abdomen was slightly distended, but there were no signs of ascites. The liver was found to be an inch below the costal margin.

The patient was quite comfortable in bed, and only complained of occasional pain between the shoulders. The liver increased rapidly in size, and ascites was discovered in October. Oedema of the legs soon appeared, and nodules could be palpated on the surface of the liver, which extended down to the level of the umbilicus. The patient gradually became weaker, and died on December 26, just over seven months after the removal of the left eyeball.

AUTOPSY.—There were a few recent adhesions between the left pleuræ in the mid-axillary line, and one of longer standing at the base connecting the visceral pleura to the parietal pleura over the diaphragm. There were no adhesions on the right side.

The left lung weighed 1 lb. 11 oz. Both lobes contained three or four hard white nodules, each with a surface area the size of a sixpenny piece. On section, a number of similar nodules varying in size from that of a sixpence to a half-crown were observed. The lower lobe was congested and was partially collapsed. The right lung weighed 2 lb. 1½ oz. The condition was similar to that of the left, but the nodules were more

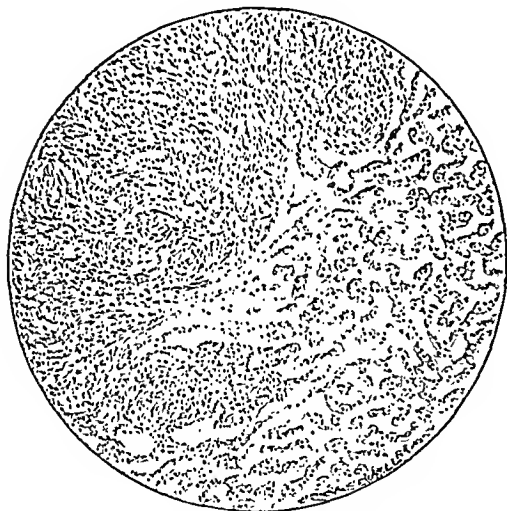


FIG. 277.—Microscopic section of a secondary deposit in the liver. The infiltration of the liver by the sarcoma is well seen.

numerous, and the larger ones on the external surface showed a tendency to pedunculation.

On opening the pericardium, the normal amount of fluid was found. The visceral layer of the pericardium contained three or four hard white nodules. The heart weighed 1 lb. 2½ oz. On the posterior surface of the left ventricle a secondary nodule the size of a Barcelona nut was found.

On opening the peritoneal cavity about 3 pints of blood-stained fluid were found. There were a few adhesions—especially between the liver and diaphragm. A small, white, hard nodule, the size of a pea, was seen in the parietal layer in the region of the splenic flexure, and several about the same size were seen in the parietal layer to the outer side of the ascending colon.

The liver weighed 17 lb. 9 oz. It extended to the level of the umbilicus, and the whole surface was studded with hard white nodules varying in size from that of a threepenny-bit to a duck's egg. One or two of the smaller ones showed umbilication. The proportion of liver tissue to new growth was about 1 to 10. On section, there was a similar appearance, but some of the nodules were much larger (*see Fig. 276*), and the left lobe contained one 7 in. across, which had broken down in the centre and was infiltrated with blood. The little liver tissue present showed marked signs of fatty degeneration.

The pancreas contained a number of small nodules the size of split peas, and the proportion of pancreas to new growth was 1 to 1. Attached to the surface of the pancreas, and adherent to the diaphragm, was a large mass 5 in. in diameter, of retroperitoneal new growth; the mass was white, lobulated, and hard.

The right kidney weighed $7\frac{3}{4}$ oz. It was normal in size, and contained a white hard nodule in one of the lower calices.

The left kidney weighed $7\frac{3}{4}$ oz. There were two or three small nodules in the perinephric fat, and a small nodular growth was seen in the substance of the cortex of the kidney.

Histological sections were cut of the liver, and of the nodules which were present in the lungs, kidneys, heart, pericardium, pancreas, retroperitoneal glands, and parietal peritoneum. In each case fibrosarcoma was obvious.

Fig. 277 shows very clearly the infiltration of a fibrosarcomatous deposit in the liver.

REVIEWS AND NOTICES OF BOOKS.

Hernia: its Anatomy, Etiology, Symptoms, Diagnosis, Differential Diagnosis, Prognosis, and Operative Treatment. By LEIGH F. WATSON, M.D., Associate in Surgery, Rush Medical College, Ill. Imperial 8vo. Pp. 660, with 232 illustrations. 1924. London: Henry Kimpton. 52s. 6d. net.

THE author has compiled a very comprehensive treatise on the subject of hernia in all its aspects, and deals with all common and uncommon conditions so completely that his work must remain for many years the most authoritative treatise on the subject. The description of the different varieties of inguinal hernia is clear, and avoids unduly complicated detail. The figures depicting the varieties of this type illustrate the text, and should be easy to bear in mind, and here, as throughout the book, the illustrations are unusually well drawn and beautifully reproduced. In dealing with treatment—and this applies equally to other sections of the volume—the author is inclined to give details of so many methods claiming to be radical cures, without any suggestion as to the indications for one particular operation, or comparison of results which may be obtained by any particular method, that we fear the book will fail to be of any great assistance to anyone looking for guidance as to the best method to be employed. In dealing with congenital inguinal hernia, one of the most important considerations is the treatment of the ectopic or undescended testicle. Much has been written on this question, and most surgeons of authority hold strong if divergent views as to what should be done, and when operation should be undertaken on undescended testicles. We must admit to disappointment that in a volume of this nature the question is dismissed in less than a page, and we fail to find any discussion on or suggestion as to a variation in treatment if both testicles are descended, as compared with one; whereas, in our knowledge, the view of many surgeons of great clinical experience is that the two conditions may demand entirely different treatment.

The chapter on ventral hernia is perhaps the best, and should be useful to those having difficulty with the very troublesome cases resulting from suppurating appendix wounds. We are glad to notice that the author favours the closure of such gaps by autoplastie fascial flaps when required, rather than by the insertion of metallic substances such as filigrees. We confess we are unable to agree with the author when he prefers the femoral to the inguinal route in operating on a femoral hernia. We do not see how by this route the femoral canal can be closed at the only point at which its closure is of value, namely, at its neck; nor can we admit that the inguinal operation leads to a weakening of the inguinal canal, for such weakening does not result from operation for an inguinal hernia in which exactly the same tissues are divided and resutured; if this opinion is correct, there can be no comparison between the two routes.

There is no more difficult problem than how to deal with a large sliding hernia: here this particular variety is clearly classified, and the problems which have to be faced in its treatment are argued without undue dogmatism. In looking through the volume we see many rare varieties of hernia and complications are dealt with. We have only looked in vain for one which passed through our mind, and that is hernia into the broad ligament.

Like the majority of such volumes coming from the United States, the book is beautifully bound and printed.

Diseases and Injuries of the Rectum, Anus, and Pelvic Colon. By J. RAWSON PENNINGTON, M.D., F.A.C.S., Proctologist to Columbus Hospital, Veterans' Hospital No. 30, and U.S. Marine Hospital, etc. Medium 8vo. Pp. 993 + xii, with 2 plates and 677 illustrations. 1923. Philadelphia: Blakiston, Sons & Co. London: Stanley Phillips. 60s. net.

THE author says in his preface that, as twenty years have elapsed since the publication of the treatise on proctology by the late James P. Tuttle, the time seems ripe for another inventory of the different affections of the rectum, anus, and pelvic colon. A novel feature of the work is the publication at the commencement of each chapter of the portraits of those surgeons who have been interested in proctology since the time of Hippocrates, a drawing of whom, made from a marble bust in the Louvre, appears on the first page.

The opening chapters are concerned with a description of the splenomesenteric funnel and a commentary upon rectal diseases in general. Chapter 3 deals with the preparation and the examination of the patient. An excellent account of the various instruments used in anoscopy and proctoscopy is given. The important subject of constipation is fully considered in the following chapter, in which we are pleased to find that colectomy is not considered to be the only means of effecting a cure of this very common condition.

A very clear account of the lymphatic systems in connection with the rectum is contained in the chapter devoted to anatomy.

Wounds of the rectum are discussed in Chapter 7, the treatment of gunshot injuries receiving special attention. All authorities appear to be agreed that laparotomy should be performed in cases of penetrating wounds of the intraperitoneal portion of the rectum. Some difference of opinion exists as to whether colostomy or enlargement of the external wounds only, in order to provide adequate drainage, is the best treatment for penetrating wounds situated below the peritoneal reflection. In our experience the question of resorting to colostomy is largely influenced by the size of the wound in the rectum. Small wounds, such as those caused by a bullet, only require perineal drainage in order to obviate perirectal cellulitis; but large wounds made by fragments of shell invariably require colostomy in addition to adequate perineal drainage.

The various causes and methods of treatment of pruritus ani are fully discussed in Chapter 10. We are in agreement with the view expressed that the great majority of cases are caused by pre-existing disease in the anal canal, such as internal piles, fissure, submucous fistula, and hypertrophied anal papillæ, and are therefore curable. The most intractable cases are those in which there is no discoverable exciting cause, and occur in individuals of a neurotic temperament.

For the treatment of fissure in ano the author advocates the use of a speculum whose blades are capable of being widely opened for the purpose of divulsing the external sphincter. He also recommends that, when the operation of incision is employed, the external sphincter muscle should be completely divided on one or other side of the fissure. In our opinion it is unnecessary to divide any of the fibres of the muscle in order to cure a fissure, as division of the fibrous deposit in the submucosa of the lower part of the anal canal generally suffices. When, however, the muscle is divided, the section is best made at the junction of the middle and posterior thirds in order to inflict as little damage as possible on the nerve supply.

Chapters 13 and 14 are concerned with abscess and fistula. The author's classification of fistulæ is novel. First of all he divides fistulæ into complete and incomplete, and then goes on to say that the latter are not fistulæ but sinuses, as they only present a single opening either internal or external. Complete fistulæ he considers to be true fistulæ, as they have both internal and external openings. Complete fistulæ are divided into three varieties according to the position of the internal opening; thus, when the internal opening is situated in the anus, an anal fistula is said to exist; in those cases in which the internal opening is located at the junction of the anal canal and the rectum, the fistula is described as anorectal; and lastly, when the internal opening is found in the rectum proper, a rectal fistula is the result. Our objection to such a classification as this is that it does not indicate

the various types of fistula that may be met with. We consider that the particular type of a fistula is determined, not by the position of the internal opening, but by the situation of the main track, which is the unobliterated remains of the original abscess cavity that gave rise to the fistula. For example, a submucous abscess may terminate in a fistula of the submucous type, and may present an internal opening at the anal margin, at the junction of the rectum and the anal canal, or higher up in the rectum, so that this type, according to the author's classification, would be described as anal, ano-rectal, or rectal according to the position of the internal opening. Moreover, a pelvirectal fistula having an internal opening in the rectum above the level of the levatores ani would also pass under the name of a rectal fistula, the term being thus applied to fistulae of vastly different types.

The subject of hæmorrhoids is fully dealt with in Chapter 18. The various operations are carefully described. The Whitehead method is condemned. Of all the methods of operating the author prefers his own, which is known as the open method. We confess to having had no experience of it; but from the author's description we should imagine that the cutting off of part of the hæmorrhoidal tumour, without previously applying a clamp to its base, might result in the patient losing a considerable quantity of blood. This is an important consideration in patients who may have been reduced to a condition of anæmia on account of previous hæmorrhages. We think, therefore, that this method is inferior to that advocated by Earle, who first places a clamp on the base of the pile, then cuts off the pile superficially to the clamp, and places a running suture along the clamped edge to control hæmorrhage when the clamp is removed.

Carcinoma of the rectum is extensively discussed in Chapter 22. A careful summary of recent work in regard to the manner in which cancer spreads from the rectum to the surrounding tissues is given, the author rightly insisting that post-operative immunity from recurrence can only be expected from an operative procedure which has been planned in accordance with the pathology of the spread of the disease. For this reason he prefers the abdominoperineal method to all others. The remainder of the book is concerned with the diseases and injuries of the pelvic colon.

The book is exceedingly well written and profusely illustrated, and we congratulate the author on having produced an excellent compendium, which should be in the possession of all those who are interested in diseases of the rectum and the progress of proctology.

Hæmorrhoids, their Ætiology, Prophylaxis and Treatment by Means of Injections.
By ARTHUR S. MORLEY, F.R.C.S., late Temporary Assistant Surgeon to St. Mark's Hospital for Cancer, etc. Demy 8vo. Pp. 114, illustrated. 1923. London: Oxford Medical Publications. 6s. net.

IN the preface of the book the author expresses the desire to clear up the confusion that exists in the minds of the profession in regard to the varieties of piles met with, and to familiarize its members with the method of treating piles by interstitial injections.

The opening chapter contains a brief account of the hæmorrhoidal veins and the anatomy of the anal canal. We do not agree with the statement that the middle hæmorrhoidal veins enter into the formation of the venous plexus about the lower part of the anal canal and the skin surrounding the anus. It is our belief that the middle hæmorrhoidal veins arise in a plexus situated on the outer surface of the rectum immediately above the levatores ani, and receive blood chiefly from the muscular coat of the bowel, taking little or no part in the formation of either the submucous or the subcutaneous portions of the hæmorrhoidal plexus. Another statement that must be new to anatomists is that the sinuses of Morgagni are situated above the anal valves, and that the anal valves are located at the mucocutaneous junction.

Chapter 2 deals with the etiology and prophylaxis of hæmorrhoids, and in the succeeding chapter external hæmorrhoids are described. We think that the term hæmorrhoid, when applied to the conditions mentioned, is a misnomer, because they do not bleed, and we much prefer the term pile, as it signifies a lump or swelling.

Internal hæmorrhoids are described in Chapter 4, a good account being given of the pathological changes that may take place in the course of their existence. Symptomatology receives ample consideration, but there is no mention of the number of internal hæmorrhoids that may develop, or of their position in regard to the circumference of the anal outlet. We regard this as a matter of considerable practical importance, because it not only enables the observer to record the number of hæmorrhoids that actually exist when he makes his examination, but renders it possible for him to determine accurately, even after the lapse of several years, that a particular hæmorrhoid, which he has either injected or removed by operation, has or has not recurred. It seems curious that the only illustration that has been chosen to depict the appearance of prolapsed internal hæmorrhoids is a typical example of the condition known as prolapsus mucosæ recti.

In Chapter 7 the author describes the technique of his method of injection. He especially emphasizes the point that all the existing piles should be injected at the same time whenever possible. The details of the technique are clearly set forth, and many useful hints are given for the guidance of those who are desirous of carrying out the method. As a rule, four injections of every pile, at intervals of a week, are required, so that three weeks are usually necessary to complete the treatment. When discussing the pathological effects of injection in Chapter 8, the author states positively that thrombosis plays no part whatever in the process. It is of course difficult to disprove this, but it does not seem reasonable that all the blood contained in a mass of dilated and tortuous veins should escape coagulation when the vessels themselves are exposed to the action of a powerful irritant. Chapter 9 deals with complications, recurrence rate, and statistics. Recurrence takes place in 16.6 per cent of the cases treated by the injection method, representing therefore a large proportion of failures. In this respect the method compares unfavourably with the operation by ligature. When an internal pile has been completely removed by ligation it cannot possibly recur. In estimating recurrence, a subsequent development of piles that did not exist at the time of the first operation should not be regarded as recurrence. The final chapter is concerned with a discussion of the advantages and disadvantages of injection, the complications after various operations, and the contra-indications to treatment by injection.

The book shows that the author has gained considerable experience in this particular method of treating internal hæmorrhoids, and has made out a good case for its adoption in suitable instances, but we cannot help feeling that it is a pity that he should allow himself to indulge in abuse of those whose opinions do not coincide with his, by a remark on page 65 that they "are either exercising their imaginations freely or are making wilful misstatements".

The Toxæmia of Acute Intestinal Obstruction: or Vomiting as a Pathological Force. By R. H. PARAMORE, M.D. (Lond.), F.R.C.S. (Eng.). Crown 8vo. Pp. 66 ÷ viii, with 1 chart. 1924. London: H. K. Lewis & Co. Ltd. 5s. net.

This volume, the author tells us, is the outcome of a criticism of the view that the visceral disabilities in eclampsia are determined mechanically, and that puerperal convulsions are simply uræmic in nature. Having criticized and rejected the commonly accepted view that the renal impairment in acute intestinal obstruction is due to toxins absorbed from the damaged gut, he seeks to establish the theory that it results from the increased intra-abdominal pressure. The renal function, according to this view, is interfered with in a purely mechanical manner, thus leading to an accumulation of non-protein nitrogen in the blood. Vomiting, by increasing

the intra-abdominal pressure, is, in intestinal obstruction, a prime factor in the causation of diminished renal efficiency. The objection that fits do not occur in acute intestinal obstruction, whilst they do in eclampsia, is disposed of by the statement that as patients with acute intestinal obstruction constantly vomit, "the material determining fits is voided".

The arguments are not easy to follow, on account of the peculiar literary style in which they are presented. On one page, for instance, there are as many as eight rhetorical questions, and on another no fewer than eight sentences or words enclosed within brackets after the manner of stage asides.

A Manual of Practical X-ray Work. By JOHN MUIR, M.B., Ch.B., B.Sc., in collaboration with Sir ARCHIBALD REID, K.B.E., C.M.G., M.R.C.S., L.R.C.P., and F. J. HARLOW, B.Sc., F.Inst. P., A.R.C.Sc. Third edition of the Manual by ARTHUR and MUIR. Royal 8vo. Pp. 524 + x, with 456 illustrations. 1924. London: Wm. Heinemann Ltd. 31s. 6d. net.

This book was first published under the joint names of Drs. Arthur and Muir. Of the present edition the authors' names and qualifications are a sufficient guarantee of the quality of the work. Much of the thoroughly practical side of the publication is traceable to the great experience of the late Sir Archibald D. Reid, and no doubt many of the illustrations are the outcome of the work he carried on throughout the years of his active life. Dr. Harlow is probably largely responsible for the physical and technical sections of the volume, and this part of the work can be confidently recommended as a guide to the student and the beginner in radiography. Dr. Muir has had a large technical experience from which he has drawn freely to make the book a thoroughly practical and reliable guide. Nearly half the volume—the first eight chapters—is devoted to a general consideration of the subject, and contains descriptions of modern apparatus, information regarding the use of X-ray installations, and the technique of the subject. The important section on photographic technique is full of useful information. Stereoscopy is adequately dealt with. These chapters are admirably illustrated.

The chapter devoted to normal radiography is carefully dealt with, many useful diagrams are incorporated, and each has a teaching value. The development of the bones is fully discussed: this difficult yet interesting study being worthy of all the care which has been bestowed upon it. The student reading for an examination in radiology would be well advised to study this subject carefully.

A consideration of the morbid conditions of the several systems is next elaborately dealt with, many valuable skiagrams are shown to elucidate difficult points in diagnosis, and the differential diagnosis of the various diseases is satisfactorily given.

The book on the whole should prove to be of value to beginners in radiology: the advanced worker will not fail to find in its pages much valuable information. No attempt has been made to deal with the treatment side of radiology, though the title might lead the reader to look for some information on the subject. The work deals exclusively with radiography, and as such must supply a want on the part of beginners.

The illustrations of skiagrams, though instructive, are not up to a high standard: this no doubt may be due in part to loss of detail in reproduction; in future editions we may look for an improvement in this respect.

We can confidently recommend the work to all radiologists, and professional men who are interested in the subject. The practising physician and surgeon will find in its pages much useful information regarding the difficult diagnosis of diseases of the various systems with which they deal; we would particularly recommend for their consideration the chapters on the diseases of the chest, the alimentary, and the urinary systems. Obstetricians will find useful information regarding the use of X rays in their specialty in the short chapter on radiology in obstetrics.

St. Bartholomew's Hospital Reports. Vol. LVII, Part I. 4to. Pp. 91, illustrated. 1924. London: John Murray. 10s. 6d. net.

THIS would be rendered delightful if for no other reason than that it contains a picture of Smithfield Market in 1830, which as a reproduction of the best kind does great credit to the House of Murray who reproduced it. H. W. W. contributes a sympathetic biography of Harrison Cripps, and does not stoop to spoil his material by omitting to mention the faults which he, in common with other men of his strength of character and confidence, possessed. Keynes' article on "Twenty-one Cases of Actinomyces" is of a type which such reports seem to live on and perpetuate. It adds a small amount of fresh clinical material to a subject already fully dealt with, but breaks no new ground nor adds any suggestion of scientific value. We have read Dunhill's paper on the parathyroids elsewhere. It is a well-worked-out study, and beautifully illustrated.

An Introduction to Surgical Urology. By WILLIAM KNOX IRWIN, M.D., Aberd., F.R.C.S. Edin., Hon. Casualty Out-patient Surgeon, St. Paul's Hospital for Genito-urinary Diseases. Crown 8vo. Pp. 180 + viii. 1923. London: Ballière, Tindall & Cox. 7s. 6d. net.

IN this book the writer sets out to describe the main facts of genito-urinary surgery 'in short compass'. Two chapters are devoted to anatomy and the examination of the patient, seven to the chief genito-urinary symptoms, and one chapter to glandular hyperplasia and malignant disease of the prostate. The plan of the book is to group the diseases of the genito-urinary system under their most prominent symptoms so as to make the diagnosis more easy. The result is somewhat confusing, for, under the heading of a symptom, the author drifts off to discuss the various methods of treatment of the medley of diseases that may cause it. Hæmaturia may be taken as an example. There is no real attempt to consider hæmaturia as a symptom and to track it to its source, and diagnose the cause. The author, after a few preliminary lines, plunges into a description of the diseases that have hæmaturia as a symptom. The account of the diseases of the genito-urinary tract is sketchy and, in many diseases, inadequate.

The book contains much information that will be useful to the general practitioner, but we doubt if it is presented in a form which he will readily assimilate.

The Gall-bladder: Its Past, Present, and Future. By J. E. SWEET, A.M., M.D., Sc.D., Professor of Surgical Research, University of Pennsylvania. Medium 8vo. Pp. 39, illustrated. Paper Covers. Philadelphia: J. B. Lippincott Co.

THIS is a reprint from *International Clinics* of the Mütter Lecture delivered before the College of Physicians, Philadelphia, in December, 1923. In it are reviewed the writings of many other workers upon the subject. There is little that is new, and most of the novelty lies in the guess-work. The author concludes that "under normal conditions whatever passes into the gall-bladder through the cystic duct never passes out again through the cystic duct". The very slender evidence in favour of this view will probably leave every reader unconvinced.

The elastic layer in the wall of the gall-bladder attracts no attention, nor does the possible function of the viscus as a concentrator of the fluid within its cavity. We are not always quite sure of Dr. Sweet's meaning, for his use of the English language is not a little slipshod. On page 2 he refers to "the longitudinal section of an embryo of 2 mm. or between 3 and 4 weeks" and seems therefore to suggest that a week is shorter than a millimetre. He frequently uses the word 'theory' when he means 'hypothesis'.

The pamphlet is accompanied by a memorandum from the manager of the medical department of the publishing company written in the laudatory style which we are accustomed to see upon the paper covers of those cheaper and more lurid types of novels displayed upon the railway bookstalls.

Orations and Addresses. By Sir JOHN BLAND-SUTTON, President of the Royal College of Surgeons of England, Consulting Surgeon to the Middlesex Hospital. Fcap. 4to. Pp. 161 + xii., illustrated. 1924. London: William Heinemann (Medical Books) Ltd. 10s. 6d. net.

THESE orations and addresses have already appeared in print, two of them in the pages of this Journal, but they are none the less welcome in this collected edition. Like all Sir John's writings, they read easily and are well illustrated. They range from an attempt to explain on natural grounds the miracles which led to the escape of the Israelites from the bondage of Egypt, to a study of the choroid plexuses of the brain. The most interesting is an account of the Aguaruna Indians, their method of making shrunken mummified heads, and their habit of wearing ear plugs and labrets; the most brilliant is the Hunterian Oration delivered on the anniversary of John Hunter's birthday, February 14, 1923. There is a good index, and the illustrations are well reproduced, but in consequence of these illustrations the weight of the book is out of proportion to its size.

Guisei si Cretinizmului in România (Goitre and Cretinism in Rumania). By DR. LIVIU CÂMPEANU, Edit. Institut. Art. Graf. "Ardenlui" Cluj (Kolozsvár, Klausenburg). Pp. 196. 1924.

THIS excellent little book is the outcome of much painstaking and valuable research on the part of the author, the head of the surgical clinic of the University of Cluj. Although written mainly in Rumanian, it contains a very full abstract of twenty-five pages in French, and the detailed statistical tables which occupy some sixty pages present no real difficulty, even to those who have no knowledge of the former language.

The book consists of three parts. The first deals with the detailed results of a systematic and exhaustive inquiry by the author into the distribution and causation of goitre and cretinism in the whole country. Two maps illustrate this part of the subject. The second part is concerned mainly with the surgical treatment of goitre as carried out in the Cluj clinic under the direction of Professor Iacobovici, chiefly in the years 1919-22, during which 122 cases of goitre were operated upon. The various kinds of goitre, the nature of the operations, and the results are all faithfully described with considerable and useful detail.

Finally, there is a short account of some interesting experimental research work carried out by the author upon dogs in which conditions of hypo- and hyperthyroidism had been artificially produced. There is also a useful bibliography of eight pages, dealing mainly with recent papers in German, French, and English.

Le Vie di Deflusso degli Ascessi Ossifluenti (The Course pursued by Abscesses originating in Bone). By DR. SANZIO VACCHELLI. 8vo. Pp. 160, with 68 illustrations. 1923. Bologna: Licinio Cappelli.

THIS book is an interesting study of the paths traversed by the extending tuberculous process originating in bone, whether of the spinal column, the pelvis, the bones of the hip, knee, or shoulder-joints. It covers for the most part ground already well known, but calls in aid the illuminating evidence of radiograms of abscess tracks and cavities delimited by an opaque substance. The most satisfactory material for this use is, the author finds, bicarbonate of bismuth in physiological saline, since it is almost non-toxic.

He arrives at the conclusion that though gravity undoubtedly plays a part in determining the spread, yet it is by no means such a path that is invariably followed; that in certain situations—for example, the mid-dorsal—an outward and upward direction is frequent even in the absence of recumbency. Moreover, it does not follow, because the initial focus in any two given cases is exactly similar anatomically,

that the abscess resulting will extend by the same route: the spread is, in fact, that of a tuberculous granuloma.

The most instructive descriptions and illustrations are perhaps those which relate to caries of the three or four upper cervical vertebrae, and to mediastinal abscesses; for even with the present-day practice of evacuating all tuberculous abscesses by aspiration, more accurate information as to the probable distribution of even the commonest of such lesions is desirable—and this book affords it. It is another of the admirable publications based on the rich clinical material of the Rizzoli Institute.

L'Intestino Crasso Prossimale (The Proximal Large Intestine). By Dr. AUGUSTO MONTANARI, Senior Medical Director of Radiology in the Umberto I Hospital at Ancona. Pp. 177, with 65 illustrations. 1924. Bologna: Licinio Capelli.

THIS book deals with the radiology of the upper half of the large intestine. The author, who is a disciple of, and was formerly assistant to, Professor A. Busi, follows the technique of the latter. On the day preceding the commencement of the examination, the large intestine is cleared by simple enemata. Purgatives are scarcely ever employed, as they influence unduly the motility of the intestine during the examination. The opaque enema used in the examination consists of 100 grm. of sulphate of barium suspended in 400 c.c. of liquid. The barium sulphate must be very pure, since the addition of traces of chloride renders it dangerously toxic.

The first third of the book deals with the normal anatomy and physiology of the large intestine in relation to radiology. The second part deals with pathology. The various pathological conditions are classified according to the symptoms which they produce. Successive chapters deal therefore with modifications of position, size, and shape of the intestine, with alterations in passive mobility, and with alterations in tone and motility.

The author lays stress on the fact that normally the colonic contents are propelled by two series of movements. One is very slow but continuous, and involves mainly the sacculi. The other is very rapid and intermittent, occurring only at long intervals (several hours). It is only during this latter movement that extensive forward propulsion of intestinal contents takes place in the colon.

The book is well printed on good paper, and the illustrations, nearly all of which are radiograms, are good and clear. A bibliography of four pages deals with Italian, French, English, German, and American literature. There are indexes of authors and subjects.

Le Paralisi Ishemiche (Ischæmic Paralysis). By FRANCESCO DE RAFFELE. Crown 8vo. Pp. 388, with 74 illustrations. 1923. Bologna: Licinio Capelli.

THIS volume is the third of the monographs published by the Rizzoli Institute, and, as Professor Putti says in his introduction, no one who wishes to undertake the study of this important clinical and pathological chapter can afford to neglect it. The history, the etiology, pathogenesis and physiological pathology, symptoms and course, diagnosis, pathological anatomy, and treatment all receive due attention; there are records of 23 cases from the Institute, and full abstracts of 244 from the literature; also records of the author's experimental studies and those of others.

But when all is said, interesting and instructive as this industrious compilation certainly is, it must be admitted that with the best will in the world the author has not been able either to disentangle a clear-cut clinical entity or to establish unequivocally its pathology—or perhaps it should rather be said that few cases can be found to conform to any definition, however carefully drawn, since ischæmia as the sole and exclusive exciting process is as rare as the phoenix.

De Raffele is on the whole an advocate of a purely myogenous etiology, but his own and other clinical examples often have definite nerve-trunk lesions as a prominent feature. He adopts the 'acute inflammatory' explanation of the

initial phase, and, a little disingenuously, adopts that definition of inflammation (from among the four-and-sixty possible—is it?) which reconciles the findings with the absence of infection or infective agents.

In describing the histological changes in the muscle, the fibrous-substitution, the action of histocytes, the indications of regeneration, he notes the interesting point that no trace of *fatty* degeneration is observable. As regards treatment of the established condition in the forearm, he is, seemingly, an advocate of osteoplastic shortening of the radius and ulna, but admits the possible advantages of tenoplasty in special circumstances, and of course neglects neither mechanical nor physiotherapeutic accessories. He recognizes that his experimental results must, like those of others, be considered as negative.

Whilst the author has not provided a final solution of the problems of ischæmic paralysis, he has produced a compact and well-arranged monograph.

A Manual of Surgical Handicraft and Physiotherapy. Vol. I. By J. RENFREW WHITE, M.S. (N.Z.), F.R.C.S. (Eng.), Assistant Surgeon and Surgeon in Charge of the Orthopædic Department, Dunedin University. Demy 8vo. Pp. 566 + xxi, with 344 illustrations. Dunedin, New Zealand: Coulls Somerville Wilkie Ltd.

ONE cannot read Mr. Renfrew White's book without feeling astonished at the enormous amount of material that he has condensed in it, and at the tremendous care that he has taken in collecting practical details of surgical methods. The first chapters on asepsis, antiseptics, and methods of sterilization present nothing out of the ordinary; the next two on the use of antiseptics and on surgical materials are a compendium of details of all sorts of antiseptic solutions and their methods of use, and of the preparation and sterilization of all surgical materials. For example, the preparation, hardening, chromicizing, and seven different methods of sterilization of catgut are described; details of preparation of solutions, of all sorts of materials such as pastes, and of hypodermic and intramuscular injections, are all given. The illustrations of methods of bandaging appear to be the most practical that have yet appeared in any text-book, and it would be hard to discover any part of the body the bandaging of which is not illustrated by two or three adequate methods. Much care is given to instruction in the tying of knots and in the use of all kinds of ligatures and sutures, details of technique elaborated by many different surgeons all being included.

Further chapters discuss preparations for operation, general operative technique, and post-operative care, and there are small sections on the treatment of wounds and ulcers, sinuses, fistulæ, etc.

This first volume deals only with surgical handicrafts. It is a book which one may say is of such value that it should be in the hands of every surgeon and every theatre sister. There is scarcely anything likely to be wanted in theatre technique that cannot be found in it. Presumably the second volume will deal with physiotherapy, and it will be looked forward to in the hope that it will reach the same high standard as does the first volume.

Care and Cure of Crippled Children. Part I, being a description of the National Scheme for the Welfare of Crippled Children, by G. R. GIRDLESTONE, F.R.C.S. Part II, being a Year-book of Hospitals, Schools, and other Institutions for Crippled Children, by Mrs. HEY GROVES. With a foreword by Sir Robert Jones, K.B.E., C.B. Demy 8vo. Pp. 88, with illustrations. 1924. Bristol: John Wright & Sons Ltd. 2s. 6d. net.

THE Central Committee for the Care of Cripples has set itself as its post-war problem the organization of the care of cripples throughout the country. The experience of military orthopædic hospitals and of treatment clinics demonstrated so clearly the importance of team work and of adequate after-care in orthopædic surgery, that to lead on to a similar organization for the care of the civilian cripple became the obvious line of development.

In this little book an outline scheme for such organization is set forth in considerable detail by Mr. Girdlestone. The arrangement and organization of a central orthopædic hospital, and the co-ordination with it of clinics amounting really to subsidiary out-patient departments, are set out in a way which is both convincing and practically helpful to those who wish to assist in extending the organization in parts of the country where it is not yet in existence. The map of England showing the existing hospitals and clinics has far too few of its counties properly filled: it has many large blank spaces where organized care of cripples is at present entirely wanting. For example, with the exception of one hospital for tuberculous disease, the whole of the Eastern Counties is a blank, and Wiltshire, Dorsetshire, Somersetshire, Devonshire, and Cornwall have no orthopædic hospital or clinic at all.

In the second section of the book Mrs. Hey Groves has collected facts about hospital schools and other institutions for crippled children which are at present in existence, with brief historical notes about them. In some of these the history given is both helpful and fascinating: for example, the Shropshire Orthopædic Hospital was founded in 1900 and then held only four girls and four boys, an old house, formerly a ladies' school, being utilized. At the present time it has 350 beds and a yearly expenditure of over £42,000. No doubt the history of many of the other institutions would be just as convincing if it were told.

The book is a small one, and should be in the hands of everyone who is interested in the crippled child. By a study of it, not only is it possible to help to organize treatment on the right lines, but it is also possible to know what parts of the country are particularly in need of organization, so that those who have the desire to do something may choose the district for which they can work.

Cancer Research at the Middlesex Hospital, 1900-1924: Retrospect and Prospect. Compiled by Members of the Staff of the Hospital and Medical School. Edited by W. SAMPSON HANDLEY, M.S., F.R.C.S. Demy 8vo. Pp. 90. 1924. London: John Murray. 3s. 6d.

This small book sets forth in popular form the work that has been done at the Middlesex Hospital in the investigation of cancer. It is written not for the scientific worker but for the general reader, appealing to him for support. The task is admirably carried out, and the book calculated to give the general public a true conception of the problems and difficulties of cancer research, and what has been done by workers in this field at the Middlesex Hospital.

Cancer du Rectum. By Professors ANDRÉ A. CHALIER and HENRI MONDOR. Royal 8vo. Pp. 601, with 105 illustrations. 1924. Paris: Octave Doin. 40 francs.

This is one of several volumes dealing with cancer of different organs and regions of the body which are being published under the editorship of Professors Hartmann and Bérard. The authors have divided the book into two parts, the one dealing with carcinomata and the other with sarcomata.

Two types of carcinomata are met with, the squamous-cell carcinoma at the anus or in the lower part of the anal canal, and the adenocarcinoma in the rectum proper. Three varieties of the adenocarcinoma are described, namely, the papilliferous, the infiltrating, and the colloid. These growths are met with (1) below the level of the levator ani, (2) between the levator and the peritoneal reflection, and (3) between the peritoneum and the rectosigmoidal junction. So far as the experience of the authors is concerned, the commonest site is the anterior wall of the bowel. In our experience the distance of the growth from the anal verge appears to influence its position. Thus, when the growth involves either the anal canal or the lower part of the ampulla, the anterior wall is most commonly affected; when the growth is situated in the upper part of the ampulla, the postero-lateral wall of the bowel is

usually affected; and lastly, when the rectosigmoidal junction is the starting-point of the disease, the whole circumference is generally involved.

In the chapter on pathological anatomy the extramural lymphatic channels by which cancer cells, detached from the original growth, are carried to distant parts, are well described. The authors have found from repeated dissection of specimens that the group of anorectal glands situated at the bifurcation of the superior hæmorrhoidal artery are invariably invaded, even when the primary growth is in a comparatively early stage of development. They also point out that spread in the extramural tissues takes place chiefly in an upward direction along the line of the superior hæmorrhoidal and the inferior mesenteric vessels, and thence towards the median aortic lymphatic glands situated near the origin of the inferior mesenteric artery. They have not been able to ascertain that spread occurs to any marked extent in the lateral or in the inferior lymphatic areas, and therefore do not regard the tissues through which these lymphatics pass as liable to be invaded in the majority of instances. We are surprised that they have not encountered metastatic deposits in the tissues of these lymphatic areas during the performance of operations, because, when discussing operability, they state that the only contra-indications to operation are general dissemination and involvement of the ureters and the urinary bladder. Consequently they must have performed operations in cases in which extramural extension of the disease was fairly well advanced. We have repeatedly observed metastases in the substance of the levatores ani in cases in which the primary growth had not penetrated the entire thickness of the rectal wall, and have detected microscopical foci in the ischio-rectal fat as the result of the systematic examination of specimens removed by operation.

We do not agree with the authors in their belief that the chief path by which the spread of cancer of the rectum takes place is in the submucous tissue. Recent observations upon this point conclusively prove that spread in the submucous tissue is very limited, and does not extend more than a few lines either above or below the macroscopical margin of the primary growth. In support of this view we may also say that we do not know of a museum specimen showing a submucous metastasis among the numerous examples of rectal cancer.

When discussing the implication of extramural lymphatic glands, attention is rightly drawn to the fact that enlargement of glands does not necessarily imply invasion by cancer cells, because the enlargement may be due entirely to inflammatory conditions associated with the septic nature of the cancerous ulcer.

The chapter dealing with the symptomatology of the successive stages of a cancerous growth is particularly good, attention being drawn to the importance of recognizing early symptoms before the disease has progressed beyond the stage of operability.

The major part of the book is devoted to the consideration of methods of treatment. It is pointed out that the treatment of cancer of the rectum is purely surgical, and that medical measures are of little avail. For cases that have passed beyond the stage of operability, the establishment of an artificial anus is essential. Left iliac colostomy is the method of choice unless the pelvic colon is so distended that it is impossible to withdraw from the abdomen a loop of sufficient size to create an efficient spur. In such instances the authors regard cæcostomy as the best procedure. There is no mention of the possibilities of transverse colostomy under these circumstances. After describing in detail all of the operative procedures that have been advocated for the removal of the cancerous rectum, the authors insist that the most radical removal is that effected by the combined abdominoperineal route, as by this means alone can the tissues involved by the upward spread of the disease be eradicated. The question as to whether the internal iliac arteries should be ligatured, as a preliminary step in the abdominoperineal operation, is discussed at considerable length, and the method of applying the ligature is fully described. We think that ligature of these arteries is an unnecessary procedure, because the only artery that supplies the rectum from that source is the middle hæmorrhoidal, which is usually so small that it seldom requires a ligature. When discussing the operation mortality following the abdominoperineal method, the authors draw

attention to the fact that, although formerly the mortality rate was as high as 50 per cent, it has now been reduced to about 17 per cent. The recurrence rate is estimated at 20 per cent, which is vastly superior to that shown by any other method.

The remainder of the book is devoted to consideration of the sarcomata that are met with in the rectum. These are divided into the melanotic and the non-melanotic. The histological appearances are fully described. The treatment recommended is wide removal whenever possible.

We congratulate the authors on having produced an excellent book, and consider that their views on the subject admirably express present-day knowledge of the pathology and surgery of cancer of the rectum.

Tuberkulose der Knochen und Gelenke. By PROFESSOR F. OENLICKER, Chief of the Surgical Clinic at Hamburg-Barmbeck. Quarto. Pp. 405, with 356 figures in the text. 1924. Berlin: Urban & Schwarzenberg. \$40.

This is a book of moderate size, well illustrated and interestingly written. The various phases of the subject are dealt with in due proportion, except that there is but little description of surgical operations or technique. As regards etiology, the author considers that infection is chiefly by way of the air and the tonsils. Tuberculous affection of bones and joints is described as a general disease with local manifestations. Prominent importance is given to light treatment both by the sun and artificial radiation. In the treatment of special lesions, the book gives a good account of plaster splinting, but is rather scanty in regard to other methods.

Études médico-radio-chirurgicales sur le Duodénum. By PIERRE DEVAL, JEAN-CHARLES ROUZ, and HENRI BÉCLÈRE. Medium 8vo. Pp. 264, with 127 illustrations. 1924. Paris: Masson et Cie. 35 fr.

THE study of affections of the duodenum apart from duodenal ulcer is of comparatively recent date. In this monograph the three authors, a surgeon, a physician, and a radiographer, have worked in close collaboration, so that the utmost has been done to correlate the general clinical picture and the X-ray observations with the conditions found on the operating table.

The first section deals with the changes which occur in the duodenum in the presence of gall-stones. When there is accompanying periduodenitis, deformations of the bulb occur which defy classification, owing to their irregularity. In a high proportion of cases they are rendered evident only when serial radiographs are taken, and only with the most painstaking care on the part of the radiographer. The impression of the gall-bladder upon the duodenum cap shadow described by George and Leonard is confirmed by the authors, but is not regarded as pathognomonic, since they find that a similar concavity in the shadow may occur with distention of the hepatic flexure of the colon. A new sign they describe is the retraction posteriorly of the pyloroduodenal segment seen only in oblique or lateral views. The interesting observation is made that after cholecystectomy irregularity in the duodenal shadow is almost the rule, as the result of adhesions, yet in many cases there are no symptoms. Sometimes, however, stenosis is so great as to require gastrojejunostomy for its relief.

An important section of the book deals with that curious condition named by the authors 'essential stenosing periduodenitis'. This is a very definite clinical condition found at operation, and presents great problems in treatment. It is systematically described here and cases are quoted. The clinical features are but vague, and consist largely of debility and neurasthenia, perhaps with attacks of pain which simulate duodenal ulcer or biliary colic, so that diagnosis rests solely upon the recognition of the condition of the duodenum by repeated radiography. One leaves this chapter of the book with a feeling of disappointment which cannot be dispelled, and is reminded of the early work on the surgical treatment of visceroptosis. Yet

no surgeon should neglect to read this very valuable account of a pathological condition of which so little is known.

A very good account is given of obstruction of the third part of the duodenum by the superior mesenteric artery. The cases appear to be more common in Duval's practice than they are in this country. Here, too, further knowledge of the pathology of the condition seems necessary before treatment can become standardized.

There is a very good section on the X-ray appearances of duodenal ulceration, and the book is completed by a discussion of duodenal intoxication due to chronic stenosis, a chapter well worth perusal.

A Descriptive Atlas of Radiographs of the Bones and Joints. By A. P. BERTWISTLE, M.B., Ch.B., Resident Surgical Officer, General Infirmary, Leeds. Crown 4to. Pp. 198 + xiv, with 300 radiographs. Bristol: John Wright & Sons Ltd. 17s. 6d. net.

This book is a collection of radiographs of the normal bones and joints and of their diseases and injuries. A unique feature is the manner in which the outline of the soft parts is shown as a silhouette. This method considerably enhances the appearance and usefulness of the skiagrams; it brings out well, for instance, the 'dinner fork' deformity of a Colles' fracture or the flattening of the shoulder in a dislocation of this joint, these features being hardly visible in the usual radiograph.

The Atlas consists of six parts: the first illustrates the usefulness and method of making silhouette radiographs, the second being a comprehensive series of skiagrams of normal bones and epiphyses. A most useful feature of this part is the collection of radiographs of the principal joints showing their epiphyses at various ages. The third part is a very complete series of fractures of bones; the fourth depicts diseases of bones; whilst the fifth shows the injuries and diseases of joints. The sixth part is an interesting collection of miscellaneous skiagrams. There is a brief but adequate description of each radiograph.

This book will be found most useful in surgical practice for the comparison of skiagrams whose interpretation is difficult. For the sake of completeness, it is a pity that no skiagrams of the normal spine between the upper dorsal and the sacral vertebrae are given, nor are any diseases or injuries of the spine portrayed.

The radiographs are all excellent, and the publishers are to be congratulated on the way in which they have been conveyed to paper.

Jahresbericht ü. d. gesamte Chirurgie. 27th year of publication. Review of 1921. Pp. 989 + xvi. 1924. Berlin: Julius Springer. \$16.40.

This well-known review and epitome has now again reached its pre-war standard of excellence. The careful way in which the references are arranged and indexed and the general completeness is a wonderful evidence of great labour and careful co-operation of many workers. When it is mentioned that no fewer than 650 papers dealing with the subject of Roentgen rays are quoted with titles and translation of the title and reference, together with a general critical introduction to this matter, and that all other subjects are dealt with in due proportion, the size and completeness of this undertaking will be realized.

Die Verhütung des Knickfusses und des Knickplattfusses. By DR. AUGUST WEINERT, Chief Surgeon to the Municipal Hospital at Sudeberg-Magdeburg. Pp. 22, with 23 figures in the text. 1923. Berlin: Julius Springer.

A DEMONSTRATION that talipes valgus and flat-foot may be treated by raising the inner edge of the sole and heel of the boot, with a method of measuring the angle of deformity and correction.

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EPONYMS.

By SIR D'ARCY POWER, K.B.E., LONDON.

XV. MACEWEN'S OSTEOTOMY.

As Charles II used to call Isaac Barrow "the unfair preacher", so Macewen might be called the unfair surgeon, and for the same reason—that both were exhaustive, leaving nothing for after-comers to improve or amend. He performed his first osteotomy for genu valgum on May 19, 1877, removing a V-shaped portion from the inner side of the condyloid extremity of the femur by means of a chisel, the rest of the bone being afterwards broken. Two other patients were operated upon in like manner in the course of the year, but at some time before March 30, 1878, he had devised a method by which the bone could be divided without removing any portion of it. His attention had no doubt been drawn to the disadvantages attending the use of a chisel by a fatal case which had occurred in the practice of a surgeon who "while operating for knock-knee introduced a chisel with the straight edge downwards, which penetrated a short distance and then sloped downwards instead of going straight in. The instrument for some reason was then removed and placed on the table. Afterwards it was picked up and reinserted; this time, however, with the straight edge upwards. After traversing the aperture first made, it began to cut a course for itself and soon turned upwards, so that the incision, instead of being straight, was zig-zag. It is perfectly needless to say that such a result would be serious, and in order to obviate this tendency, another form of instrument ought to be used.

"The form most suitable for the simple osseous division is one bevelled on both sides, so as to resemble a very slender wedge. Such an instrument passes easily into the bone and maintains the direction given to it by the hand, having no tendency to glide to one side or the other. It is very easily withdrawn and does not tend to become fixed in the same way as a chisel with a shoulder such as a carpenter's. The instrument must be thoroughly trustworthy. From what I have been able to gather through others, ordinary carpenters' chisels have been used by some surgeons and they have been surprised that some of them have been broken, leaving small pieces of steel in the interior of the bone. Now the steel ought to be made to suit the

material upon which it is to act, not only in respect to its form, but also as to its temper, and the 'stuff' of which it is made. It ought to be made of very fine steel, tempered so as to prevent brittleness or too great softness. If it be brittle it may leave a portion of metal in the tissues; if too soft it will turn and curl up at the edge; of the two evils the latter is the less.

"I have had several sets of instruments manufactured for me, but the most trustworthy and satisfactory have been made by Mr. Maedonald, who put himself to some trouble to carry out my instructions concerning them and also in determining the exact temper necessary. As the latter is a matter of considerable importance the particulars arrived at may be mentioned in a couple of sentences. They were made from Stubbs' finest five-eighths steel, forged at a low heat; tempered by raising the instrument to a cherry-red heat, dipping it into oil and then plunging it into water until cold; next polished, and about an inch of the chisel, measuring from its cutting edge, having its temper drawn back by raising it to a copper-yellow colour with purple spots (probably a temperature of 550° Fahr.). In these instruments only a small portion of the chisel, embracing the cutting edge, is raised to a great degree of hardness; the remainder of the blade is comparatively soft, so as to avoid the possibility of snapping. Though this is applicable to all chisels, it is particularly so to the finest, especially when used in cases where the bone is very thick and the instrument has to be deeply inserted. A good material for testing the edge of the instrument is the hough-bone of an ox. If one finds that the instrument will neither turn nor chip in penetrating such a bone, it may be concluded that it is well-suited for cutting any human bone. These instruments stood this test. I have found them to possess the qualities of great hardness combined with toughness, and hitherto, although used on some very hard and dense human bones, they have neither turned nor chipped. The handle and the blade form one piece. The handle is octagonal, and I prefer it to the oval or cylindrical, as it gives a better grip, and enables the operator to detect more readily any deviation which the instrument may assume. The top of the chisel is furnished with a rounded projecting head against which the thumb of the operator rests as he steadies the instrument; it also serves as a support whereby the instrument may be gently levered out of the section. The figures 1 and 2 are placed near the head on the surfaces which correspond to the thickness of the blade in order that they may serve as a means of distinction when the blade is obscured in the tissues. The borders of the blade are marked with half inches, the figures being extremely light. The figures point out the depth to which the instrument has penetrated and thus serve as a guide. They are finely polished, not for appearance, but because the finer the surface the less opportunity will organic matter have of becoming adherent and afterwards decomposing.

"Now although there is nothing new in the principle on which this instrument is formed, yet its exact counterpart cannot be found out of surgery; and, though clearly of the chisel order, it has sufficient individuality to enable it to take a distinctive name. As the blade in shape resembles somewhat a transverse section of the blade of a pocket knife, and as it cuts much in the same way, it might be described as a knife for cutting bone; or, to employ a single word which would at once distinguish it from the ordinary chisel



SIR WILLIAM MACEWEN

and at the same time be more euphemistic to a patient's ear, it might be called an osteotome."—and an osteotome it has remained to this day.

"In operating, the scalpel is introduced at once to the bone and a longitudinal incision is made a little longer than the breadth of the instrument. Through this wound the osteotome is introduced longitudinally until it comes in contact with the bone when it is turned transversely. . . . When the operator thinks the bone has been sufficiently divided, the osteotome is laid aside, a sponge saturated in 1 in 10 carbolized watery solution is placed over the wound, the surgeon holding this in one hand grasps the limb lower down and gives it a quick jerk inwards, when the bone will snap or bend as the case may be. The elastic webbing placed on the limb prior to the operation to restrain the cutaneous bleeding is now removed. As soon as the vascularity of the limb has been restored a pad of gauze is placed over the wound and the splint applied."

The whole account, which appears as a clinical lecture on antiseptic osteotomy delivered at the Glasgow Royal Infirmary in the *British Medical Journal*, 1879, i. 656-8, is of extreme interest if it be remembered that the lecture was delivered in the early spring of 1879. It shows that Macewen had invented and perfected the operation of linear osteotomy which he had performed for the first time less than a year before. It shows, too, that he had grasped the first principles of aseptic surgery, for he caused his newly invented instrument for cutting bone to be forged in a single piece and to be highly polished, when other surgeons were still using bone-handled scalpels and wooden-handled chisels. The influence of Lister is visible in the elastic webbing applied to arrest cutaneous bleeding as well as in the use of a sponge wring out of carbolic lotion.

Sir William Macewen was born in the Island of Bute on June 22, 1818, the youngest son of John Macewen who had been in business at Rothesay and was afterwards master of the "Breadalhane", a yacht employed during the summer months to carry Free-church Ministers to and from the islands of the West Coast of Scotland. He graduated at the University of Glasgow in 1869, served as resident at the Royal Infirmary, and in 1870 became Superintendent of the Bêlvidere Fever Hospital. He soon resigned the post, but not until his interest had been aroused in the cerebral complications of middle-ear disease, an interest which was further fostered by Dr. Alexander Robertson, the Physician Superintendent of the Parochial Hospital. Acting as a general practitioner, as a parochial medical officer, and as a police surgeon, he had so impressed his fellow-citizens that he was appointed Visiting Surgeon to the Royal Infirmary in 1877 at the unusually early age of 29. He held this post until 1892, when he was appointed Regius Professor of Surgery in the University, and Surgeon to the Western Infirmary.

During the war he acted as Consulting Surgeon to the Navy, he operated at the Hospital at Mount Stuart, and he took a great part in establishing and carrying on the Princess Louise Scottish Hospital for Limbless Sailors and Soldiers. He was decorated C.B. for these services, having already received the honour of knighthood in 1902. In 1895 he was elected F.R.S.; in 1923 he filled the office of President of the British Medical Association, and earlier in the same year he was President of the International Society

of Medicine in succession to Dr. W. W. Keen, of Philadelphia. He died of pneumonia with all his faculties unimpaired on March 24, 1924, shortly after his return home from a visit to Australia, New Zealand, and the United States of America.

Tall, lithe, and handsome, Macewen's personal appearance was as striking as his mind was above the average. He may be placed amongst the greatest of the British surgeons not only of his own generation but perhaps of all time, both for originality of thought and for the way in which he carried his ideas into action. He was equally great as a pioneer in cerebral surgery, in the surgery of the lung, in the surgery of bone, and in those experimental branches of natural history to which he applied his leisure hours. He was fortunate in the time of his birth, for during the most impressionable years of his life, Lister was revolutionizing his branch of the profession, and the science of bacteriology was being developed. He saw the advantages of both; adopted the one with modifications of his own, and made full use of the other.

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ACUTE 'GENERAL' PERITONITIS AND ITS TREATMENT.

By W. SAMPSON HANDLEY, LONDON.

(Being a Hunterian Lecture delivered before the Royal College of Surgeons of England on February 12, 1924.)

THOUGH some of my conclusions may find a wider application. I shall deal in this lecture with peritonitis of appendical origin, by far the most common variety in the experience of the general surgeon.

The expression 'acute general peritonitis' is well understood clinically, as implying an unlocalized, spreading, suppurative peritonitis of grave import, unlimited by adhesions, and producing characteristic clinical signs, especially a distended, tender, rigid abdomen, with a rapidly rising pulse and a falling temperature, repeated vomiting becoming effortless in character, and cessation of the passage of flatus and feces. So-called general peritonitis following appendicitis is very rarely universal: indeed in a twenty years' experience I can only recall one case in which the whole peritoneum was affected. This was in a boy of ten who presented no signs of obstruction and made a rapid recovery after simple drainage with removal of the appendix. The infective organisms were not sufficiently virulent to extend into and paralyse the intestinal muscle, although abundance of pus was present throughout the abdomen, even up to the dome of the diaphragm. This case incidentally helps to show that, apart from obstruction, peritonitis is not necessarily a lethal condition—a point to which I shall return.

There are few subjects in which surgery has made greater strides within living memory than in the treatment of peritonitis. Much is owing to the labours of Mickulicz, Lawson Tait, J. D. Malcolm, Treves, and others. Taking the last twenty years, the work of Dudgeon and Sargent on the pathological side, and of J. B. Murphy on the therapeutic side, is of outstanding importance. Murphy recommended removal of the septic focus if possible, drainage of the peritoneum by way of the pelvis, continuous administration by the rectum of saline infusion in large amounts, and the Fowler position during convalescence. Using these methods, Murphy was able to produce a series of 49 cases of progressive free peritonitis with only 2 deaths. The general adoption of his methods has greatly lowered the mortality, and, as was said by Mr. H. W. Carson in a recent address, they have robbed peritonitis of half its terrors.* Murphy's methods failed, however, to recognize, or at any rate to recognize fully, the importance of the intestinal paralysis which accompanies the severer forms of peritonitis. Though the Murphy methods, as Carson estimates, have lowered the mortality by 20 per cent, the residual mortality remains a considerable one (according to Gerster, 14 per cent), and

* H. W. CARSON, "The Evolution of the Modern Treatment of Septic Peritonitis", *Lancet*, 1923, May 19.

this is the case even when they are supplemented by the administration of pituitrin and escrine. The use of these substances in combination is advocated on experimental grounds in a recent paper.

Sir John Bland-Sutton has recommended the intraperitoneal use of flavine solution (Browning) to arrest the spread of peritonitis, and experience has convinced me of its value. Several ounces of a 1-1000 solution may be introduced into the peritoneum without fear of toxic effects.

There are cases, however, in which all these measures fail. In some instances of streptococcal peritonitis the infection is so intense—as in one case I met with—that within twelve hours of the onset of symptoms the hands and feet are cold, the pulse running, and the patient moribund. But certain cases in which the accepted treatment fails do not belong to this hopeless fulminating variety of peritonitis; there is another group of cases, fortunately not common, which progress more slowly to a fatal issue, in spite of the most energetic treatment on accepted lines. It is to these exclusively I would ask attention in this paper, for they are cases frequently abandoned to a fate which seems inevitable, but which is in fact avoidable. The surgeon folds his hands instead of re-opening his instrument bag. He is flaccid with resignation when he ought to be taut with resolve. The characteristic feature of these cases is the failure of treatment to produce any action of the bowels, and they are dying of intestinal obstruction. The surgeon's passivity in such instances is often determined by the belief that paralysis affects the whole length of the bowel. This is not the case. The paralysis affects only certain portions, and it is amenable to treatment on the same lines as mechanical obstruction. Indeed, as Mr. Garnett Wright has insisted, the obstruction may be merely mechanical, that is to say, it may be a multiple kinking of intensely inflamed coils of bowel, glued together by plastic lymph. Perhaps more often it is due to an actual acute myositis of the inflamed bowel.

It will be necessary to trace the course of events in a case where perforation of the appendix determines the onset of an acute spreading peritonitis. In doing so I am not offering a fancy sketch, but a résumé of my experience in the operating theatre built up into a composite picture.

An area of the peritoneum of greater or less extent around the original septic focus is the first to be attacked. This zone of direct peripheral spread is, however, usually a limited and unimportant one because it can drain. Wherever the original focus is situated, the fluid exudate from this area is carried by gravity to the bottom of the pelvic cavity. Here no drainage is available. The pelvis fills from below upwards with turbid fluid, soon becoming purulent. The pelvic intestines are immersed in a bath of pus, and the peritoneal inflammation may soon extend to their muscular wall. They become intensely congested, oedematous, and thickened, and are usually contracted rather than distended. In many cases, even at this stage, they lose their muscular power altogether, and if they are thus paralysed the clinical condition is that which I described in 1914 as ileus duplex.* Often, however, it is not at so early a stage that intestinal obstruction is produced.

The first stage of general peritonitis is, then, a pelvic peritonitis. Not

* HANDLEY, "Ileus Duplex", *Brit. Jour. Surg.*, 1915, iii, 161.

infrequently, even now, adhesions may localize the inflammation, and a pelvic abscess results.

If, however, the inflammation remains unlocalized, the further course of events is as follows. Pus fills up the pelvis, and then extends as a rising flood among the suprapelvic intestines, inflaming and paralyzing them, and producing a characteristic modification of the clinical aspect of the case. By this time, in almost all cases, and before the peritonitic flood has reached the level of the umbilicus, the intestinal paralysis is complete in the lower districts of the abdomen. From the moment when intestinal obstruction comes on, the case pursues a downhill course with increasing velocity, and the upper abdomen becomes as distended as the hypogastric region. The main toxic factor has hitherto been absorption from the peritoneal cavity, it is henceforth absorption from the distended intestines. No doubt the peritonitis continues its upward spread, aided and accelerated by intestinal distention, but long before it becomes universal, and often before it has spread much above the level of the umbilicus, the patient dies—not of peritonitis but of intestinal obstruction.

It is difficult formally to prove clinical statements based mainly upon observations made in the stress of emergency operations. It has been my custom to ascertain the condition of the upper abdomen either by passing upwards from the wound a sterile swab held in forceps, or by looking up in the cavity while the anterior abdominal wall is lifted away from the intestines by a right-angled retractor to which a vertical pull is applied. Even in 'general' peritonitis I find that the evidence of inflammation rarely extends above the umbilicus. The stomach and jejunum are distended if the case is a late one, but these and the other abdominal viscera are not inflamed. The vigorous and copious vomiting of the early stages of peritonitis shows that the stomach at any rate has not lost its peristaltic power, and the same is presumably true of the jejunum and the transverse colon. The fact that these viscera are essentially intact, though distended and embarrassed by obstruction lower down, forms the basis of successful treatment. In support of these observations I shall now give in some detail an account of the last necropsy on a case of general peritonitis which I had the opportunity of seeing.

The patient, a girl, aged 8, admitted four days after the onset of acute appendicitis, had in the interval been treated only by purgatives. Her pulse



FIG. 278.—A median strip, of the anterior parietal peritoneum extending from the pubes nearly to the ensiform cartilage. Below is seen on the surface of the specimen a portion of the urachus. The arrow indicates the level of the umbilicus.

The figure shows below an intense peritonitis which gradually lessens until, near the upper end of the strip, the peritoneum is almost normal. The specimen forms a kind of 'Nilometer' of the rising peritonitic flood.

was 140 and her condition barely justified a hasty operation. She died the following day. At the operation pus was found in the abdomen extending between the coils of intestine up to a level two inches below the umbilicus. About twelve inches of ileum, lying at the bottom of the pelvis, were glued together with lymph and dark purple in colour, with injected vessels and loss of serous lustre.

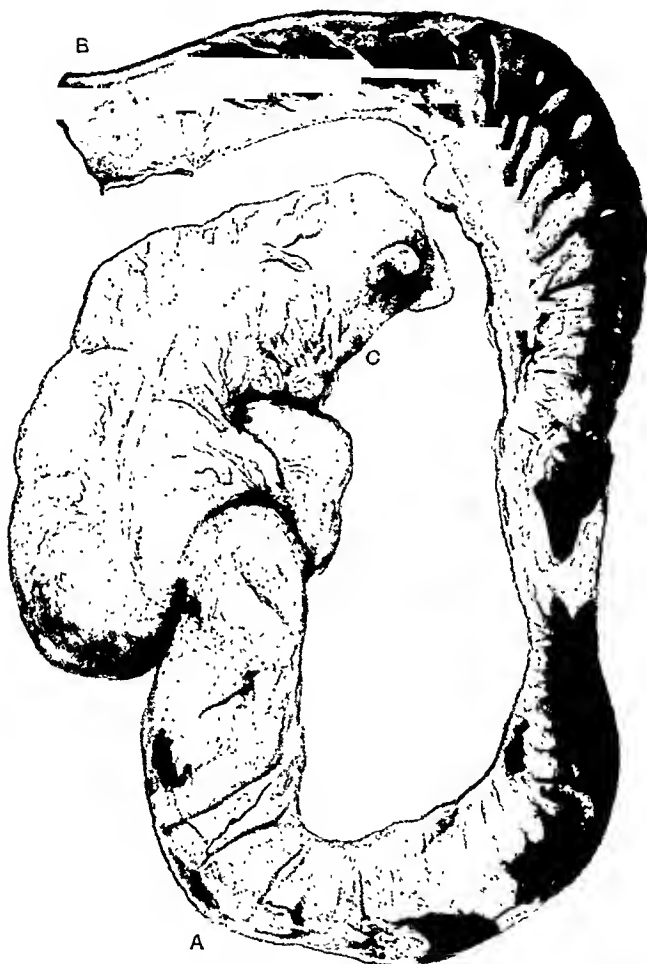


FIG. 279.—The caecum and terminal portion of the ileum. The caecum and the short portion of ileum lying above the pelvic brim (A to C) are slightly congested but are not acutely inflamed. No lymph is present on their surface. But the proximal ileum (A to B), which of course lay in the pelvis, is intensely congested, collapsed, œdematous, roughened, and covered with scattered patches of greenish lymph.

A, Level of pelvic brim; B, Proximal portion of ileum; C, Distal portion of caecum.

NECROPSY, Oct. 21, 1917.—The peritoneum of the anterior abdominal wall in the suprapubic region was intensely inflamed and covered by necrotic green lymph in a thick layer. Higher up it showed intense congestion up to a level about an inch below the umbilicus. Faint congestion extended to a

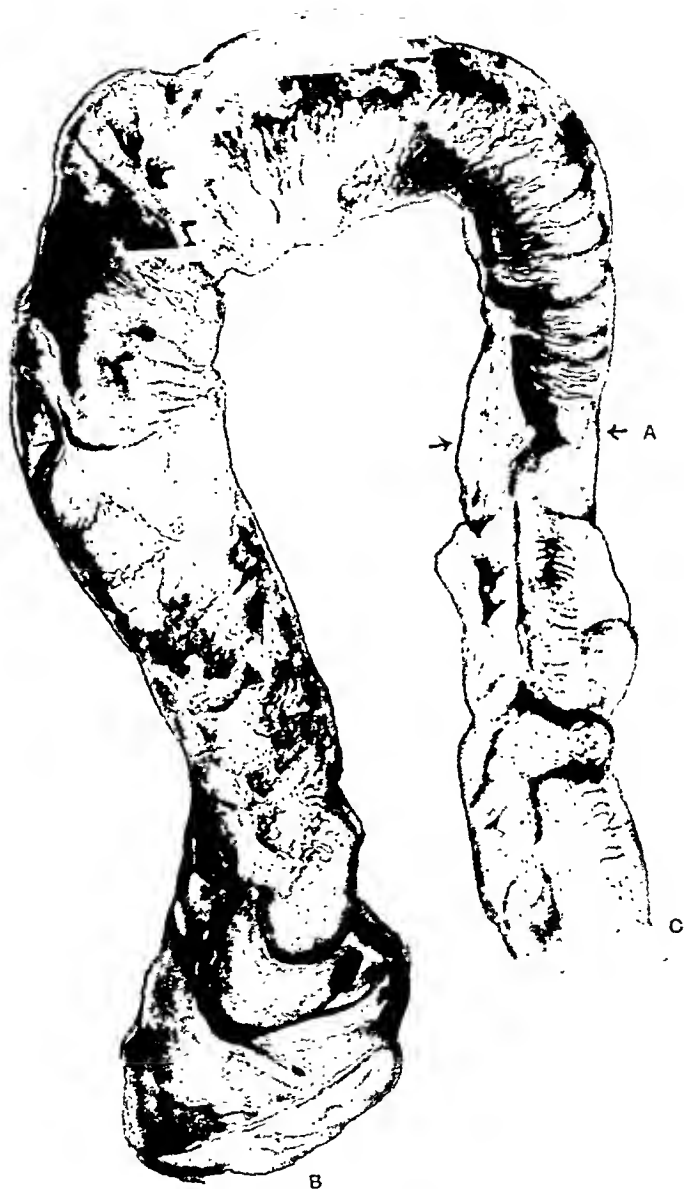


FIG. 280.—The pelvic colon with the lowest portion of the suprapelvic colon. The pelvic colon (A to B) is intensely inflamed, collapsed, and thickened by edema. The suprapelvic colon (A to C), though congested, shows a relatively mild degree of peritonitis, and the intensity of the inflammation progressively decreases from the floor of the pelvis upwards.

A, Level of pelvic brim; B, Bottom of recto-uterine pouch; A C, Proximal small portion of suprapelvic colon.

level two inches above the umbilicus. Careful inspection showed lymph on its surface three inches higher than the level where congestion ceased (*Fig. 278*). The omentum was inflamed, but when it was raised there was no congestion of the upper coils of jejunum behind it, though they were covered by pus and lymph. The upper small intestine was distended. All the small intestine below the umbilicus was intensely congested, bathed in pus, and covered with lymph.

The small intestine was now removed. Starting from the ileocecal valve it was practically normal in colour for two inches. The next four and a half feet, representing the pelvic ileum, were intensely inflamed, coated with lymph in patches, collapsed, and thickened by œdema (*Fig. 279*). Congestion eased six feet above the ileocecal valve. The upper eight feet of the small intestine (jejunum) were somewhat distended, but not thickened or œdematous. The upper large intestine was collapsed and for the most part congested. The pelvic colon, on the other hand, was congested, dusky, and thickened by œdema (*Fig. 280*). Evidence of the relative freedom of the upper abdomen from inflammation is further afforded by the following observations. There was no lymph on the spleen. The liver showed no evidence of peritonitis except on the right renal impression, where a little lymph was present. The surface of the stomach was free from peritonitis. There was a trace of lymph on the diaphragm, but it was otherwise normal to the naked eye.

So far I may claim to have proved: (1) That general peritonitis begins in the pelvis and spreads gradually upwards; (2) That the patient dies before the peritonitis has become universal, and often before it has reached much above the umbilicus.

What is the Cause of Death?—Sargent and Maybury maintain that the terminal event in streptococcal cases is a septicæmia, but I believe this is only true in the rarest and most acute cases, and that nearly always the proximate cause of death in suppurative peritonitis is intestinal obstruction. The obstruction is a local not a general one. The fatal dose of poison is usually absorbed from the intestine above an obstruction and not from the peritoneal cavity. Sir Cuthbert Wallace laconically stated in a recent discussion, "If the bowels can be made to act, the patient recovers; if they fail to act, he dies"—a fact which is conclusive as to the importance of obstruction. It is the predominant lethal factor in these cases.

I have already shown that if peritonitis does not produce obstruction it may become universal without being fatal. Later I shall produce evidence that if obstruction is relieved, recovery is the rule in cases otherwise inevitably fatal.

Time of Onset of Obstruction.—The time of onset of obstruction varies much. It may come on while peritonitis is still restricted to the pelvis (ileus duplex); it usually supervenes in the hypogastric stage before the peritonitis has reached the level of the umbilicus.

Position and Extent of Obstruction.—In pelvic peritonitis with obstruction, the paralysed segments of bowel are (1) the pelvic coils of ileum, and (2) the pelvic colon, hence the name 'ileus duplex', indicating the presence of two obstructions, one in the small and one in the large intestine. If peritonitis has spread up to the hypogastric region before obstruction occurs, more extensive and less defined tracts of the bowel are thrown out of action.

But as the inflammation does not extend above the umbilicus, it is safe to assume that at any rate the stomach, jejunum, and transverse colon still keep unimpaired their contractile power.

There is evidence to show that the small intestine is first paralysed, and only later the pelvic colon. Sometimes, judging by the continued passage of small amounts of flatus in cases with clear symptoms of complete obstruction, only the small intestine is paralysed; but it is never safe to assume that obstruction of the large intestine is absent. It may be added that after suitable treatment the large intestine recovers its peristaltic power earlier than the small intestine.

Prevention of Peritonitis.—Turning from the pathological to the clinical aspects of the subject, it will be convenient here to say something about the prevention of peritonitis. The avoidance of delay in operating, of unnecessary transport of the patient, of purgatives, are points that must be mentioned. At the operation it must be remembered that if peritonitis begins in the pelvis, pelvic drainage is the first essential towards its prevention. For many years I have made it a rule in all cases of appendicitis where there has been delay in calling upon the surgeon, or where mid-line hypogastric rigidity, rectal tenderness, or pain in urination suggest pelvic involvement, to begin the operation by making a small median hypogastric incision and introducing a swab to the bottom of the rectovesical pouch. In a recent case I detected thus the earliest stage of pelvic peritonitis. The pelvic intestines appeared normal except for slight distention, and so, too, on withdrawal did the swab, until closer inspection showed on its under surface a yellowish stain, about the size of a shilling, of purulent fluid. A gangrenous appendix, surrounded by adhesions, was found at the brim of the pelvis.

Those who adopt the rule of mid-line exploration and drainage of the pelvis for all cases of appendicitis not obviously early and well localized, will find collections of turbid fluid in the pelvic cavity with surprising frequency. In such cases, if the pelvis had not been drained, pelvic abscess or general peritonitis would have inevitably resulted.

It may be objected that pelvic exploration involves a risk of infecting the pelvis. This is certainly the case if the exploration is made from a right iliac incision through which an inflamed appendix has been removed, and, moreover, it is not possible to drain the pelvis satisfactorily from a right iliac incision. If, however, the exploration is median and is the first step in the operation, the risk of infection is avoided.

If the pelvis is found uninflamed and intact, the small hypogastric incision is sutured before the inflamed appendix is removed through a separate right iliac incision.

Clinical Stages of Peritonitis.—Turning now to the clinical stages of peritonitis, three stages are to be distinguished.

1. *Stage of Pelvic Peritonitis.*—Along with pyrexia, quick pulse, and cutting, constant, pelvic pain, aggravated by occasional intestinal colic, this stage is characterized by certain abdominal signs and certain signs obtained by vaginal or rectal examination. On abdominal examination there is found hypogastric distention and tenderness, but no abdominal rigidity is present, except such as may be found in the immediate neighbourhood of the original

septic focus. On rectovaginal examination, there is acute tenderness and perhaps œdematous thickening of the rectovesical fold of peritoneum and thickening of the uterosacral ligaments. These signs may be found within the first few hours, even though the primary focus, e.g., a perforated duodenal ulcer, is situated high up in the abdomen. Obstruction may or may not supervene at this stage. If it does, the condition is that of *ilens duplex* which I described in 1914, and which is to be regarded as an early stage of a spreading peritonitis.

2. *Stage of Hypogastric Peritonitis.*—Intervening between the pelvic stage and the typical or text-book stage of a spreading peritonitis is an intermediate stage which may be called hypogastric peritonitis, and to this I desire to direct particular attention. It is, I think, important that it should be fully recognized, for though it inevitably and rapidly passes into the third stage, it is amenable to treatment if promptly recognized. The pulse tends to rise and the temperature to fall. The patient is obviously getting rapidly worse, and is himself anxious and in extreme discomfort. Vomiting is vigorous and in considerable amounts up to two pints at not very frequent intervals, differing entirely from the frequent effortless overflow of small quantities which occurs later. It may or may not be offensive.

On examining the abdomen, the characteristic feature is the presence of distention and rigidity, tenderness, and immobility in its lower half, while above the umbilicus it is flat or only slightly distended, still soft, and only moderately tender. On palpation, a large, resonant, rounded swelling, almost as definite in its upper outline as the distended bladder and reaching about to the level of the umbilicus, can be felt in the hypogastric region. This swelling may be called the 'hypogastric football', and is doubtless formed of distended small intestine coils more or less glued together. It affords presumptive evidence of the presence of complete obstruction in the small intestine. Throughout this stage, however, small quantities of flatus may in some cases be obtained by the use of turpentine enemata, eserine, and pituitrin, and on some occasions these remedies may produce even at this stage copious evacuations, followed by the disappearance of the hypogastric swelling and the recovery of the patient, as in a recent case of my own.

The condition of the upper abdomen in hypogastric peritonitis is rather variable. It is not rigid, and still moves slightly with respiration. At first it is flat or only moderately distended, but the distention rapidly increases, and the stretching of the muscles thus produced may be mistaken for genuine rigidity.

3. *Terminal Stage.*—The hypogastric stage of peritonitis is a short one, passing perhaps within twenty-four hours into the terminal stage. The abdomen now becomes greatly and uniformly distended, for even the stomach has filled with foul fluid, and the distention extends along the small intestine as far as its inflamed segment, which is now of considerable length, since the upward spread of the inflammation has by this time involved most of the ileum. Rigidity has extended to the region above the umbilicus. The stomach begins to share in the muscular paralysis of the intestine, and the vomiting in consequence changes its character. It becomes frequent and effortless, and each time only an ounce or two of foul-smelling fluid is brought

up. It is purely mechanical and due to high pressure of fluid and gas in the stomach. This type of vomiting is exactly comparable to the escape of gastric contents from the mouth which so often occurs after death when putrefactive distention of the abdomen comes on. By the time this kind of vomiting sets in, the patient's condition is hopeless. The signs briefly are those of acute general peritonitis as described in the text-books—shrunk face, cold extremities, running pulse, and subnormal temperature; and survival is to be measured by hours. This stage might fitly be termed the 'clinical picture' or hopeless stage.

Treatment by Jejunostomy.—Priority in the successful treatment of peritonitis with obstruction belongs to my colleague, Victor Bonney, whose pioneer work on the subject has received insufficient recognition. Its publication in 1910 antedated my own independent work on parallel lines. Bonney advocated the treatment of paralytic ileus due to peritonitis by the operation of jejunostomy. The operation is applicable either to the pelvic or the hypogastric stage of a peritonitis. It is an easy and a brief operation, making little demand on the patient's vital powers, and this is a great advantage. In the cases for which Bonney used it, it was very successful, but they were mostly instances of mild peritoneal infection, or non-inflammatory paralysis, following operations for the removal of infected cancers of the cervix. Even if it had been proved that the operation would be equally successful in the intense peritoneal inflammations following appendicitis, the objection in my opinion remains that not only does jejunostomy necessitate a second operation within a fortnight for the resection of the jejunum, but that meantime, by reducing the available absorptive surface, it robs the patient of much-needed fluid and nutriment at a time when he urgently requires all he can absorb.

Treatment by Ileo- or Jeuno-colostomy combined with Cæcostomy.—My own aim in the treatment has been to construct, above the level of the peritonitic flood, a complete emergency alimentary canal, providing a considerable area of absorptive surface. I have compared this policy with that of a man whose house is invaded by a rising flood. He must leave the ground floor and make temporary provision on the first floor for all the primary needs of life until the flood subsides.

Treatment in the Pelvic Stage.—If obstruction comes on in the pelvic stage of peritonitis (ileus duplex) and fails to yield to treatment, the right course in my opinion is to do an ileocæcostomy and to tie a catheter into the cæcum. This method has proved uniformly successful in my hands, though in five earlier cases treated merely by appendectomy and peritoneal drainage four deaths occurred, and in seven cases treated by ileocolostomy alone five deaths took place. This stage is shown in *Fig. 281*.

Treatment in the Hypogastric Stage.—If obstruction occurs in the hypogastric stage of peritonitis, it must be assumed that the whole of the ileum is inflamed and paralysed, and probably also the sigmoid flexure and pelvic colon. Here my plan has been to select a distended but uninflamed coil of the jejunum and to anastomose it either to the transverse colon or the ascending colon, it matters not which. A Paul's tube is then tied into the cæcum (*Fig. 282*).

During the last nine years, out of a large number of operations for acute

appendicitis, I have met with four cases of general peritonitis in the hypogastric stage, all of them infections of the gravest type. In all of them the usual treatment of appendectomy, pelvic drainage, the Fowler position, saline infusion, and the administration of eserine, pituitrin, and purgatives was perseveringly tried. In all of them, nevertheless, the patient had reached a

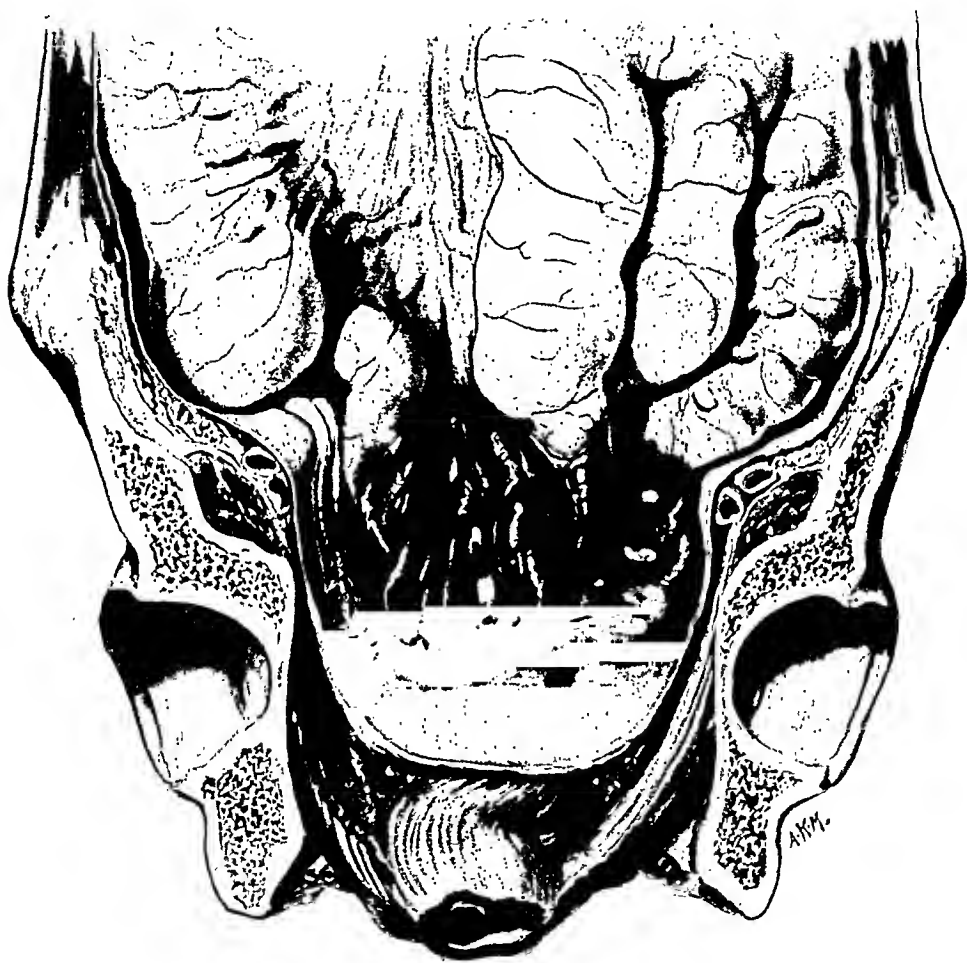


FIG. 281.—Ileus duplex arising from gangrenous pelvic appendicitis. The pelvis is occupied by a pool of pus bathing the inflamed pelvic ileum and pelvic colon. The last two inches of the ileum is normal. The supra-pelvic ileum is much distended, but is neither paralysed nor inflamed. A fairly sharp line separates it from the inflamed portion of the ileum. There is no peritonitis above the pelvic brim.

condition absolutely hopeless according to my previous clinical experience. They were all dealt with on the plan I have outlined. The abdomen was re-opened and a jejunocolostomy followed by a caecostomy was done as rapidly as possible with a minimum of handling of the intestinal contents.

In all four cases the operation was followed within forty-eight hours by softening and subsidence of the abdomen, the cessation of vomiting, and the return of natural evacuations per anum. The peritonitis ceased to spread and the patient's general condition rapidly improved. In three of the cases complete recovery occurred with spontaneous closure of the cæcal fistula. In the



FIG. 282.—Hypogastric peritonitis with obstruction and its treatment by jejunocolostomy combined with cæcostomy. Note that the peritonitis diminishes from below upwards, and that the intestines above the umbilicus, though much distended, do not seem sufficiently inflamed to impair their contractile power.

fourth case the streptococcal infection was so intense that although the peritonitis subsided and normal bowel actions returned, the patient died a month later of typical pyæmia with multiple abscesses.

It is upon the clinical evidence of these four cases that I rely in the main

to show that death in appendical peritonitis is really due to intestinal obstruction. Remove that factor and the patient recovers. The unsuccessful case is the most instructive of all. It shows that if intestinal obstruction be averted, peritonitis as such is a recoverable disease, even if the peritoneal infection is so intense as to end in pyæmia.

The treatment of these very acute cases of general peritonitis makes demands not only on the surgeon's initiative and technical skill, but on his moral courage and resolution. If the accepted methods fail to produce relief, the painful necessity of advising a second operation must be faced without delay. Only thus can a disaster be averted.

ILLUSTRATIVE CASES.

Case 1.—Miss H., age 30, had for some months complained of vague abdominal pain at intervals, but had not sought medical advice.

On Dec. 29, 1915, she was taken ill with what was supposed to be a chill on the liver. She kept at her work, and did not consult a doctor. The following day vomiting began, and was repeated soon after she took a purgative. The abdominal pain, of a colicky character, was situated in the lower part of the abdomen. On Dec. 31, she went to town as usual, but was sick and ill, and the pain persisted. Jan. 1, she was worse, and was then first seen by Dr. A. J. Hogg, of Ealing. He found that she had general severe abdominal pain and tenderness, worse on the left side. There was little movement of the abdomen on breathing. The vomiting had been bilious, and the temperature was 100°, the pulse about 90. At 6 p.m. on the same day the pulse was quicker and the temperature higher. There was great pain in the lower part of the abdomen, and she lay on her back with her legs drawn up. On this day for the first time there was pain on micturition, and in the evening Dr. Hogg asked me to see her with him with a view to operation. About 10 p.m., when I saw her, her pulse was 120, her colour good, and she did not appear to be in much distress. There was slight general abdominal distention, and the abdomen moved to a certain extent with respiration. There was no true abdominal rigidity. In the right iliac fossa an indefinite resistance could be felt. On pelvic examination, there was extreme tenderness in the region of the pouch of Douglas, with fixation of the uterus, thickening of the right uterosacral fold, and some resistance in the right broad ligament. The periods were regular, the last one having ceased a fortnight previously. The patient's statements as to the passage of flatus were rather vague, but she did not appear to have passed it more than once in the preceding twenty-four hours.

In view of the early colicky hypogastric pain, of the signs on the right side of the pelvis, and of the pain on micturition, together with the absence of abdominal rigidity and the presence of resistance in the appendix region probably due to swollen ileocolic glands, we arrived at the conclusion that the patient was suffering from pelvic appendicitis. It was thought, in view of the continued vomiting, that intestinal obstruction was likely to complicate the case.

FIRST OPERATION.—Immediate operation was decided upon, and a median hypogastric incision was made. On opening the peritoneum a certain amount of clear fluid escaped. The omentum was adherent in the pelvis, and on separation it was found to be sloughing at its tip. The coils of small intestine, which now came into view, were rather congested, but had not lost their lustre. The pelvis was packed off from the rest of the abdomen, and on passing the hand down into it, some ounces of thick pus escaped, and a mass was found which, on extraction, proved to be a swollen and gangrenous appendix containing two large concretions. There was superficial sloughing of a portion of the cæcum near the base of the appendix. All the intestines in the lower abdomen were distended by flatus and rather congested, but there were no areas of œdematous, collapsed, and deeply-congested intestine such as are seen in typical cases of ileus duplex. The condition appeared

to be general paresis of the pelvic and suprapelvic intestines without any actual paralysis, and it seemed likely that eserine and pituitary extract would maintain peristalsis in the damaged gut, but it appeared safer to tie a catheter into the cecum and bring it out through the median wound. The pelvis was drained by two large tubes.

After the operation the patient was placed in the Fowler position, saline was administered subcutaneously to the extent of about six pints for the first twenty-four hours, and injections of eserine salicylate were given every six hours in order to produce intestinal contractions. The catheter, either because it was blocked, or because there were no contractions in the intestine, did not act. Turpentine enemas were given, but only produced a little fecal-stained fluid, and no flatus passed per anum. A purgative failed to act, and forty-eight hours after the operation the condition of the patient was most alarming. The abdomen up to the umbilicus was rigid, hard, and tensely distended like a football. Above the umbilicus the distention was not so marked; rigidity was absent, and there was some abdominal movement with respiration. The pulse had risen in frequency. The patient was not sick, but was troubled by constant feelings of nausea which made her unwilling to take nourishment.

SECOND OPERATION.—Since I have never seen a patient recover from a similar condition of general peritonitis with complete obstruction, I told the friends that recovery was improbable in any circumstances, and certainly impossible unless something further was done. It appeared certain that the peritonitis had extended as high as the level of the umbilicus, and that the whole of the ileum and the lower colon were suffering from paralysis, the result of the peritonitis. The condition of the abdomen above the umbilicus showed, however, that the upper part of the small intestine—say, roughly, the whole of the jejunum—was still capable of normal peristalsis. Though the ascending and descending colon were probably paralytic, the transverse colon lying at the upper limit of the peritonitic area might be presumed still to retain its contractile power. A lateral anastomosis between the lower jejunum and the transverse colon seemed, therefore, to be the rational method of treatment if combined with a cæcostomy to afford a free exit for the contents of the large intestine.

The friends of the patient consented to further operative measures, and through an incision 4 in. long situated $1\frac{1}{2}$ in. to the right of the middle line and extending downwards to an inch below the umbilicus, I re-opened the abdomen.

The incision exposed the lower border of the transverse colon, which was distended by flatus and apparently not inflamed. Just below the transverse colon I made a small opening in the great omentum, and thus obtained access to the upper small intestine. The first coils which presented (belonging probably to the upper ileum or lower jejunum) were too much distended and inflamed to permit of their use for the lateral anastomosis—a proof that the peritonitis had actually extended up to the umbilicus. Two fingers introduced in a direction upwards to the left succeeded in withdrawing a higher coil, which though distended was not inflamed. This coil was brought forward in the opening in the great omentum and clamped. A clamp was next applied to the closely adjoining portion of the transverse colon, which also had been brought out into the wound. The area was packed off, and a lateral anastomosis was made in the usual way. Since the small intestine, owing to distention and slight œdema, did not hold stitches well, a portion of the great omentum was drawn down over the suture line so as to strengthen it. The bowel was returned and the abdominal incision was sewn up. The cæcum was next sought in the original wound at the point where the catheter was tied in it, and here a Paul's tube was inserted.

AFTER-HISTORY.—The patient bore the operation well, and her pulse at the end of it was about 120. It should be added, as indicating the virulence of the bacteria present, that the whole of the surfaces of the original incision were at this time covered by a superficial grey slough. The result of this operation was most satisfactory. It was followed by the administration of a purgative, and the following day the cæcostomy had acted well. A certain amount of fluid material together

light brown in colour; vomiting continued. On the 15th the bowels were freely open, and from this date to the 17th there were repeated large liquid actions, though very little drained from the cæcal tube. Subsequent improvement was rapid and continuous, the cæcostomy closed spontaneously, and he left the home with his wounds healed on June 24, 1923. His present condition (Jan., 1924), is satisfactory, and there is no undue looseness of the bowels.

In this case the absence of absolute constipation before the anastomosis, the promptitude with which loose actions per anum began after it, and the smallness of the discharge from the cæcal tube, show that the pelvic colon had not shared in the complete paralysis of the pelvic and hypogastric small intestine. This was not altogether an advantage, for it involved the risk that the empty and thirsty colon might absorb a fatal dose of toxins from the septic contents of the obstructed small intestine which reached it via the anastomosis. Between the 14th and the 17th, while the bowel was emptying itself, toxic symptoms were prominent and the pulse attained a maximum of 135. The pulse-rate subsequently fell. It remained at about the rate of 100 until May 29, and fell to 80 before he left the home.

THE CHOLESTEROL CONTENT OF THE BLOOD IN RELATION TO GENITO-URINARY SEPSIS.

By WILLIAM MacADAM AND CECILIA SHISKIN, LEEDS.

IN the surgical treatment of cases of obstruction in the lower urinary tract, especially that due to prostatic enlargement, there are two aspects of the patient's general condition which have to be considered in deciding on the nature of the operative procedure required, and on the most favourable time for its successful performance. These are:—

1. *The Functional Efficiency of the Kidneys.* Defective renal function may be either of a permanent type due to gross interstitial and glomerular changes in the kidney, or of a temporary nature due entirely to the effects of mechanical back-pressure.

2. *The Capacity of the Patient to Resist the Spread of Sepsis in or to the Upper Urinary Tract and Renal Parenchyma,* since a local focus of infection in the form of a cystitis of greater or less degree is almost invariably present in these cases.

1. As regards the estimation of defective renal function, it was the consensus of opinion in the recent Discussion at the Royal Society of Medicine¹ (1922) that functional tests, and especially the estimation of the blood-urea nitrogen, do give some real information—conclusions which were in keeping with the results of an investigation previously carried out by Dobson and one of us (W. MacA.)². From the surgical point of view it was concluded that the blood-urea estimation is a reliable guide to the functional capacity of the kidney; that its estimation should be a routine procedure in every case of enlarged prostate before operation; and that where there is evidence of nitrogen retention, prostatectomy should be postponed until the blood-urea has become normal as the result of suprapubic drainage or other treatment.

2. But the second question of the possible spread of sepsis to the kidney seems to be even more important, and it is one in regard to which clinical examination alone often fails to give a satisfactory answer. To quote from the remarks of K. M. Walker³ at the discussion on tests of renal function: "Most of us appear to have been let down at one time or another by our functional tests, and it would seem that there exists a factor which we have at present no means of estimating, when assessing the risks of an operation. I am convinced that sepsis is the factor that so frequently upsets our calculations and defies our tests. Many patients who are said to have died of renal inefficiency after prostatectomy have, in my opinion, died rather of sepsis superimposed on a damaged kidney . . ."

For some time we have devoted attention to the elaboration of a test which might be of practical value in estimating this factor of sepsis, especially in cases where the clinical signs are few or uncertain.

The tendency to a condition of acidosis in cases of infection⁴ suggested a possible means of determining the presence of a pyclitis or pyelonephritis in genito-urinary surgical conditions, but our investigations into the changes in reaction and alkali reserve of the blood in cases of prostatic enlargement led only to equivocal results. We then turned our attention to the possible value of estimations of the cholesterol content of the blood, and the present paper is an account of our findings.

CHOLESTEROL METABOLISM IN RELATION TO IMMUNITY.

Both experimental research and clinical observation seem to show that cholesterol plays an important rôle in the processes of immunity. It is said to stimulate the production of antibodies, but its precise function is still undefined. Chauffard demonstrated that severe infections are always accompanied by a marked hypocholesterolemia, while Landau⁵ first pointed out that the suprarenal cortex shows a very low content of lipid material in patients who have died of bacterial and especially pyogenic infections.

On the other hand immunization processes have been shown to be accompanied by an exceptionally high cholesterol content of the blood. An attempt has been made by Barbary⁶ to make some practical application of this knowledge concerning one of the functions of this important lipid. By injections of cholesterol in combination with camphor, which he believes stimulates the production of cholesterol, there is a rapid increase of the cholesterol content of the blood; and in the case of soldiers suffering from septic wounds he found that the mortality was diminished and the period of convalescence shortened as compared with control cases which received no such injections.

SCOPE OF INVESTIGATION AND METHODS OF PROCEDURE.

It was decided to investigate the cholesterol content of the blood in a series of cases of urinary obstruction due to enlarged prostate—where, of course, there is usually some degree of cystitis—in order to determine whether such an investigation might afford any evidence of the amount of resistance to the spread of infection, and of the possibilities of ‘surgical kidney’ or other form of renal sepsis supervening.

Eighty-eight cases of prostatic obstruction confirmed by operation or post-mortem examination have been examined. In the course of the investigation many other genito-urinary conditions, such as urethral stricture, vesical calculus, papilloma of the bladder, renal hypernephroma, etc., have been examined incidentally, but our protocols bear reference only to cases of prostatic enlargement.

Blood was obtained by venous puncture before any operative interference, whether suprapubic drainage or prostatectomy, was carried out. This is of considerable importance, because, as described below, a marked fall in blood-cholesterol is an almost invariable sequela of any operative procedure.

The urea nitrogen of the blood was also estimated in all cases in order to compare the relative incidence and importance of nitrogen retention and hypocholesterolemia in genito-urinary obstruction.

The estimation of cholesterol was carried out by a slight modification of Myers and Wardell's method, as described by us⁷, while the urea nitrogen was estimated by Folin and Wu's method⁸.

THE BLOOD-CHOLESTEROL OF NORMAL PERSONS AND ITS VARIATION WITH AGE AND OTHER FACTORS.

Using this method of Myers and Wardell, we found the cholesterol of the blood plasma in a series of twelve normal cases—all except one under 50 years of age—to vary between 0.191 per cent and 0.133 per cent, with an average of 0.161 per cent. These values are in agreement with those of other workers, e.g., Chauffard, Laroche, and Grigaut⁹, whose figures are 0.150 per cent to 0.180 per cent. It has to be remembered that, as all our cases are over 50 years of age, the average normal cholesterol content should be reckoned as somewhat higher, since a hypercholesterolemia is commonly associated with arteriosclerosis, granular kidney, and other degenerative conditions of the later periods of life.

ANALYSIS OF RESULTS.—Of the 88 cases there were 14 of malignant prostate, and the cholesterol findings in these will be discussed separately. Of the 74 cases of benign enlargement of the prostate, prostatectomy was carried out in 56, either as a single or two-stage operation. The remaining 18 were considered unsuitable for major operation, sometimes on clinical grounds alone, in many instances as a result of our laboratory investigations. This applies especially to the later cases, when increasing confidence in the value of the test allowed us to express an opinion as to the operative risk of prostatectomy. Hence in 13 cases, suprapubic drainage alone was carried out, while in the remaining 5, catheterization was resorted to.

Of the patients, 27 died, and an autopsy was obtained in all except four. It has thus been possible to correlate fully our findings with the degree and distribution of sepsis present.

It should be noted that there has been no selection of cases. The great majority were hospital patients of the Leeds General Infirmary, many being admitted as urgent cases of urinary obstruction, and practically all suffering from a greater or less degree of cystitis.

ANALYSIS OF CASES HAVING A LOW BLOOD-CHOLESTEROL. (*Table I.*)

As mentioned above, the average normal cholesterol content is 0.160 per cent, with a range of variation from 0.130 per cent to 0.190 per cent. From an analysis of the cholesterol findings in the present investigation, we have concluded that all values below 0.130 per cent may be taken as abnormally low, and signify that the patients possess little resistance to bacterial infection, and are poor 'operative risks'.

Thus, out of the total series of 88 cases, 18 gave a cholesterol content less than 0.126 per cent. Of these 16 died of pyelonephritis, or other form of renal sepsis, and 2 recovered. From the clinical standpoint, only 10, or just over 50 per cent, were considered bad surgical risks, and it is noteworthy that 8 of these were suffering from marked renal inefficiency, as shown by their having a high blood-urea content.

Prostatectomy was carried out in 5 of these patients, and 3 died. Of the others, suprapubic cystotomy was performed as a measure of relief in 7 cases, while the remaining 6 were catheterized.

Table I.—ANALYSIS OF 18 CASES WITH LOW BLOOD-CHOLESTEROL (BELOW 0.130 PER CENT), WITH 16 DEATHS AND 2 RECOVERIES.

CASE NO.	CLINICAL CONDITION	OPERATIVE TREATMENT	BLOOD		RESULTS AND POST-MORTEM FINDINGS
			Cholesterol	Urea Nitrogen	
3	Poor	C	0.089 grm.	25 mgrm.	Death. Pyelonephritis
10	Fair	C	0.126 "	75 "	" Multiple abscesses in kidneys
11	Fair	C + P	0.092 "	42 "	Recovery
12	Fair	C	0.106 "	56 "	Death. Pyelonephritis
18	Poor	C	0.109 "	75 "	" Pyelonephritis
23	Very poor	Nil	0.070 "	30 "	" Pyelonephritis and malignant prostate
36	Fair	C	0.103 "	26 "	" Pyelonephritis
37	Poor	Nil	0.120 "	25 "	" Pyelonephritis
46	Fair	P	0.125 "	25 "	" No post-mortem. Pulmonary embolism (?)
47	Fair	C + P	0.104 "	22 "	" No post-mortem
56	Poor	C	0.118 "	48 "	" Pyelonephritis
69	Fair	C + P	0.108 "	39 "	" Multiple abscesses in kidneys
73	Poor	Nil	0.105 "	24 "	" Pyelonephritis
75	Fair	C	0.083 "	28 "	" Pyelonephritis
78	Poor	Nil	0.120 "	84 "	" No post-mortem
80	Poor	Nil	0.116 "	88 "	" Pyelonephritis and chronic nephritis
83	Fair	P	0.109 "	20 "	Recovery
86	Poor	Nil	0.122 "	56 "	Death. Pyelonephritis

C = Cystotomy. P = Prostatectomy. C + P = Two-stage operation. Nil = Catheterization.

ANALYSIS OF DEATHS IN CASES WITH A NORMAL OR HIGH BLOOD-CHOLESTEROL.

Of the 11 deaths occurring in patients with a cholesterol content over 0.130 per cent, an autopsy was obtained in 10 cases (*see Table II*). Only 1 (*Case 74*) showed acute pyelonephritis, and this was a case of adenocarcinoma of the prostate. In addition, *Case 63* died from a pelvic abscess and faecal fistula four weeks after removal of the prostate. A false passage had been produced by a metal catheter before the patient's admission to hospital. Free hæmorrhage had resulted, and prostatectomy had been carried out in the single-stage operation. The findings in this case, we think, can scarcely be reckoned on a par with the usual course of a urinary obstruction which terminates in renal sepsis.

The remaining autopsies in the cases with high or normal cholesterol content revealed no evidence of sepsis apart from the usual cystitis, the causes of death being cardiosclerosis (3 cases), acute and subacute nephritis (2 cases), and pneumonia, pulmonary embolism, and post-operative hæmorrhage (1 case each).

Table II.—ANALYSIS OF DEATHS IN CASES WITH A BLOOD-CHOLESTEROL OVER 0.130 PER CENT.

CASE No.	CLINICAL CONDITION	OPERATIVE TREATMENT	BLOOD		CAUSE OF DEATH
			Cholesterol	Urea Nitrogen	
2	Fair	P	0.247 gm.	17 mgrm.	Sudden death—cardiosclerosis
6	Poor	C	0.270 "	42 "	Malignant prostate and acute nephritis
16	Fair	C	0.354 "	31 "	Sudden death — cardiac failure
28	Fair	P	0.157 "	14 "	Pneumonia
44	Fair	P	0.180 "	25 "	Pulmonary embolism
63	Poor	P	0.167 "	22 "	Pelvic abscess; fecal fistula (see text)
67	Fair	P	0.257 "	87 "	Subacute nephritis
72	Fair	P	0.340 "	34 "	Arteriosclerosis with heart failure
74	Poor	C	0.160 "	20 "	Malignant prostate and pyelonephritis
79	'Uræmia'	C	0.213 "	160 "	No post-mortem
85	Fair	P	0.138 "	20 "	Post-operative hæmorrhage

P = Prostatectomy. C = Cystotomy.

RELATION BETWEEN THE CHOLESTEROL CONTENT OF THE BLOOD AND NITROGEN RETENTION,

From our experience of Folin and Wu's method of estimation of the urea nitrogen of the blood, we consider any figure over 30 mgrm. per cent as significant of defective renal function in middle-aged or elderly subjects. Expressed in terms of urea this is equivalent to values higher than 63 mgrm.

In the present series of 88 patients, 15 gave a blood-urea nitrogen over 40 mgrm. per cent, and therefore suffered from a gross renal inefficiency (*Table III*). It is seen that 8 of these gave at the same time a low blood-cholesterol. In spite of suprapubic drainage to relieve the back-pressure all died except one, post-mortem examination revealing some form of renal sepsis in all 6 cases which were examined.

The remaining 7—that is, those whose blood-cholesterol was not diminished—were drained until the blood-urea content was within the normal range before prostatectomy was carried out, and all recovered except the 2 who showed evidence of the most marked degree of nitrogen retention (*Cases 67 and 79*).

Thus the patients who showed considerable nitrogen retention due to mechanical back-pressure caused by prostatic enlargement, but who reacted well to suprapubic drainage, were those who evidently possessed considerable resistance to bacterial infection, as suggested by a good cholesterol figure. The following are the complete figures of one of our cases:—

Case 49.—Age 76. On admission very ill: uræmic, marked cystitis.

DATE	CHOLESTEROL	UREA NITROGEN
Sept. 16, 1922	0.180 gm.	75 mgrm.
Sept. 16, "		
Oct. 2, "	0.142 gm.	39.2 mgrm.
Oct. 8, "	0.158 "	26.2 "
Oct. 9, "	Prostatectomy.	Convalescence uneventful.

Table III.—RELATION BETWEEN BLOOD-CHOLESTEROL AND NITROGEN RETENTION, 15 CASES WITH HIGH BLOOD-UREA.

CASE No.	CLINICAL CONDITION	OPERATIVE TREATMENT	BLOOD			RESULTS AND POST-MORTEM FINDINGS
			Cholesterol	Urea	Nitrogen	
<i>A.—8 Cases with low blood-cholesterol, of which 7 died.</i>						
10	Fair	C	0.126 gm.	75 mgrm.		Death. Multiple abscesses in kidneys and chronic nephritis
11	Fair	C + P	0.092 "	42 "		Recovery. Long convalescence
12	Fair	C	0.106 "	56 "		Death. Pyelonephritis
18	Poor	C	0.109 "	75 "		" Pyelonephritis
56	Poor	C	0.118 "	48 "		" Pyelonephritis
78	Poor	Nil	0.120 "	84 "		" No post-mortem
80	Poor	Nil	0.116 "	88 "		" Pyelonephritis and chronic nephritis
86	Poor	Nil	0.122 "	56 "		" Pyelonephritis
<i>B.—7 Cases with normal or high blood-cholesterol, of which 2 died.</i>						
13	Fair	C + P	0.173 "	40 "		Recovery
25	Fair	C + P	0.206 "	62 "		"
49	Fair	C + P	0.180 "	75 "		"
50	Fair	C + P	0.164 "	56 "		"
64	Fair	C + P	0.143 "	42 "		"
67	Fair	C + P	0.257 "	87 "		Death. Subacute nephritis; cholelithiasis
79	Fair	C	0.213 "	160 "		" No post-mortem

C = Cystotomy. C + P = Two-stage operation. Nil = Catheterization.

On the other hand, the results were almost uniformly unsatisfactory in cases showing considerable nitrogen retention with, in addition, a low cholesterol content.

There was no fall in blood-urea nitrogen after cystotomy—indeed the nitrogen retention was often more marked—after a fortnight's drainage. An example of such a finding is the following:—

Case 12.—Age 73. Clinically 'fair condition'. No pyrexia.

DATE	CHOLESTEROL	UREA NITROGEN
Aug. 10, 1922	0.106 per cent	56.6 mgrm. per cent
Aug. 10, "	Cystotomy	
Aug. 21, "	0.100 per cent	72.8 mgrm. per cent
Sept. 13, "	Death. Acute pyelonephritis with chronic cystitis.	

Such findings suggest extension of sepsis to the portion of renal tissue still functioning, while they afford evidence that "the occurrence of sepsis at the time of, or following operation, may damage the remaining portion of renal substance, and therefore put the patient in grave danger."¹⁰

THE POST-OPERATIVE FALL IN BLOOD-CHOLESTEROL.

The above findings raise the question: "Does suprapubic drainage ever raise the cholesterol content as well as lower the blood-urea?"

Such an increase in the cholesterol value is rarely to be seen, and herein lies the chief fallacy to be guarded against in assessing the significance of cholesterol estimations. Other factors than those associated with antibody formation appear to influence the blood-cholesterol, and special emphasis must be laid on the fall in the lipid content of the blood, which appears to follow any operative procedure. This was strikingly shown in the course of an investigation carried out by us⁷ on the effects of splenectomy on cholesterol metabolism in acholuric jaundice and splenic anaemia. After removal of the spleen there was invariably a fall in blood-cholesterol during the first fortnight, which was uniformly low in the conditions investigated, to be followed by a rapid and progressive increase in lipid content during the next few months.

A similar post-operative fall was a common observation in many of the cases of the present investigation. Even a minor operation, such as a suprapubic cystotomy, whether performed under a local or general anaesthetic, produces this effect. The flaring up of sepsis would doubtless be a contributing factor, but this will not explain the fall in many of the cases after operation.

BLOOD-CHOLESTEROL IN MALIGNANT DISEASE OF THE PROSTATE.

Luden¹¹, working at the Mayo Clinic, has shown that the blood-cholesterol is usually high in malignant disease. In our series of 88 cases, there were 14 suffering from carcinoma of the prostate, and in these the average blood-cholesterol was 0.178 per cent. Only one gave a distinctly low value, viz., *Case 23*, in which the cholesterol was 0.070 per cent, one of the lowest values of the series, while there were two borderland cases with 0.128 per cent. The patient (*Case 23*) was distinctly febrile at the time of investigation, his general condition was very poor, and he suffered from a severe and foul cystitis. Post-mortem examination revealed multiple abscess formation in the kidneys.

It is difficult to determine the number of these cases that were suffering from renal sepsis, as most of the patients were discharged from hospital as soon as the diagnosis of malignancy was established and their urgent symptoms were relieved. Two others of these 14 patients died while in hospital, viz., *Case 74*, with a cholesterol content of 0.160 per cent, and in whose case pyelonephritis was found at autopsy, and *Case 6* who died suddenly, and whose blood-cholesterol was 0.270 per cent. Autopsy revealed a hæmorrhagic cystitis with a recent acute nephritis, but there was no septic infection of the kidneys or other organs. The adrenals were distinctly rich in cholesterol, while it may be noted in connection with the hypercholesterolemia that the patient also suffered from cholelithiasis.

It appears, therefore, that the blood-cholesterol in malignant disease of the prostate is of a higher average value than that of patients suffering from simple adenomatous enlargements. Hence a case of prostatic carcinoma may give a value considerably above 0.126 per cent although the patient may be suffering from pyelonephritis, a low figure being obtained only in cases of advanced and extensive infection. This exception, however, does not detract from the value of cholesterol estimations in the benign form of prostatic enlargement, since the preliminary cystotomy or other mode of examination is usually sufficient for the diagnosis of carcinoma.

SUMMARY WITH CONCLUSIONS.

1. In the treatment of cases of urinary obstruction due to prostatic enlargement, two factors have to be taken into account in deciding on what operative procedure shall be required, and when, viz.: (a) The degree of defective renal function present; (b) The capacity of the patient to resist the spread of sepsis to the upper urinary tract, since a cystitis of greater or less degree is usually present.

2. An endeavour has been made to discover a test which should be of practical value in estimating this factor of sepsis, especially in cases where the clinical signs of its presence are few or uncertain. We find that the cholesterol content of the blood appears to be a fair measure of the degree of resistance to infection possessed by the individual, and are of the opinion that such estimations form a useful practical guide to the degree of operative risk in cases of urinary obstruction.

3. Of unselected cases of prostatic obstruction, 88 have been investigated, of which 18 gave a low cholesterol value, viz., less than 0.130 per cent. Of these, 16 died of pyelonephritis, while 2 recovered. Of the other 11 deaths in the series in which the blood-cholesterol was 0.130 per cent or higher, only one death was due to an ascending urinary infection.

4. In only about 50 per cent of the patients with a low cholesterol value who subsequently died of pyelonephritis did clinical opinion of the general condition of the patient contra-indicate operation. Moreover, all these cases showed more or less defect in renal function, upon which, rather than upon the latent sepsis, did the clinical manifestations depend.

5. In many instances, therefore, no certain information as to the resistance of the patient to post-operative spread of sepsis is afforded by considering the patient's clinical condition alone. Nor does the degree and type of local sepsis in the form of the cystitis, which is present in greater or less degree in all such cases, provide reliable information as to the powers of resistance of the individual. In cases of marked cystitis, both high and low cholesterol values were obtained.

6. We suggest that a low 'blood-cholesterol' in a case of acute or chronic retention due to prostatic enlargement is significant of a low capacity for antibody formation, and points to the case being a bad operative risk as regards prostatectomy. The value of cholesterol estimations is further enhanced by their affording information as to a low bacterial resistance, even when the clinical manifestations of such are absent or uncertain.

7. Genito-urinary sepsis with the risk of ascending infection is of more serious prognostic import than nitrogen retention from defective renal function. Thus a high blood-urea alone is not necessarily serious as to ultimate prognosis, since cases of nitrogen retention which gave a normal or high cholesterol value acquired a normal blood-urea content after a period of suprapubic drainage. When prostatectomy was thus postponed, uniformly successful results were obtained, and a rapid convalescence ensued.

On the other hand, the combination of a high blood-urea and a low cholesterol content is of very serious prognosis, and points to an undoubtedly bad surgical risk. Of 8 such cases in this series, all died save one.

8. The test described is of much less value in cases of malignant disease of the prostate, where high or normal cholesterol figures are often present even when pyelonephritis exists. Low figures are obtained only in advanced or extensive infection. This discrepancy is probably to be accounted for by the high cholesterol content of the blood commonly met with in malignant disease.

To the surgeons of the Leeds General Infirmary we desire to express our thanks for their courtesy in permitting us to carry out these observations on cases under their care. We would especially acknowledge our indebtedness to Mr. J. F. Dobson, at whose suggestion we took up this investigation, for his constant valuable criticism and advice, and to Professor M. J. Stewart for affording us facilities for carrying out the laboratory work in the Pathological Department of the University of Leeds.

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JUXTA-AMPULLARY CARCINOMA OF WIRSUNG'S DUCT.

By GEOFFREY HADFIELD, BRISTOL.

INTRODUCTION.

CANCER arising in the ampulla of Vater or in the juxta-ampullary portions of the ducts which open into it has considerable surgical interest. The growths themselves are comparatively miniature in size and relatively benign; severe obstructive symptoms appear promptly, often before metastases are found; and except that jaundice is usually severe enough to add considerably to the operative risks, these cases are often favourable to surgical interference.

The anatomical localization of these tumours is often difficult: their histological characters seem to afford the safest criteria of their origin. Rolleston has collected 19 cases of cancer arising in the plicated gland-bearing mucosa of the ampulla itself, and mentions that of 21 cases recorded as being "cancer of the ampulla", only 6 appear to be true cancer "*du pylore pancréatico-duodénale*" of Hanot. Some of these growths arise in the termination of the common bile-duct and are columnar-celled, whilst carcinoma of the mucous membrane covering the duodenal surface of the papilla, or arising in its contained Brunner's glands, would seem to be relatively frequent. Juxta-ampullary carcinoma of the pancreatic duct has been seldom described. Carnot and Harvier¹ and Luzzato² have published undoubted cases. The following case is of interest as being an example of juxta-ampullary cancer of this type, and, in addition, presents several points of interest in diagnosis.

CASE REPORT.

T. G., male, age 48, was admitted to the General Hospital, Bristol, on Aug. 3, 1923, complaining of jaundice and increasing weakness.

HISTORY OF PRESENT ILLNESS.—Was in good health until the end of June, 1923, five weeks before admission. Then had an attack of 'gastritis' with severe epigastric pain and vomiting, was away from work one week, noticed general irritation of skin. About the middle of July the vomiting recurred, he noticed he was often giddy, his appetite was poor, and there was increasing weakness. Jaundice appeared at the end of July; the weakness, anorexia, and vomiting continued. He noticed that he was losing weight, that his stool was clay-coloured, and that any fatty food made him vomit.

PAST HISTORY.—Twenty years ago a vague of history of "catarrh of the liver", but no jaundice. No other illness. Venereal infection denied. Never a heavy drinker.

CONDITION ON ADMISSION.—A thin, spare man, rather deeply but not intensely jaundiced; the tint of the skin and sclerotics was a rather deep yellow. Liver dullness extended nearly half-way to the umbilicus in the

middle line. Surface smooth; gall-bladder not felt. No abnormality in chest. Nothing felt per rectum. Urine deep yellow in colour, loaded with bile pigment: no excess of urobilin present.

Blood.—Wassermann reaction, negative. Van den Bergh reaction, delayed direct type: 17·5 units.

Feces.—Total fat 30 per cent of dried weight: neutral fat 17 per cent of dried weight: fatty acid 13 per cent of dried weight: i.e., slight excess, but fairly well split. (N.B.—This figure is probably explained by the fact that (1) obstruction to the common bile-duct was partial, and (2) an accessory pancreatic duct was present.)

COURSE OF ILLNESS.—The weakness increased: he was often drowsy, and occasionally irritable and irrational. The jaundice steadily deepened; a few petechiæ appeared in the skin. There was no fever. Anti-syphilitic treatment had no effect on the signs or symptoms. A diagnosis of extra-mural obstruction of the common bile-duct, probably malignant in nature, and located in the head of the pancreas, was made, and exploratory laparotomy decided upon. The liver was found enlarged and smooth. The gall-bladder, almost completely concealed by the enlarged liver, was the size of a large William pear. No thickening of its wall, adhesions, or gall-stones were found. The common bile-duct was considerably dilated, and along its course in the head of the pancreas a chain of four or five closely-set, enlarged glands could be felt. No stones were palpated in the extra-hepatic ducts; the head of the pancreas felt rather swollen and somewhat nodular. A condition of non-calculeous obstruction of the common duct in the region of the head of the pancreas was diagnosed, and an anastomosis between the gall-bladder and the antero-superior surface of the stomach performed, this being considered the most suitable operation for cases of this type. The gall-bladder on aspiration was found to contain a thin, opalescent, and practically colourless fluid. Little shock followed the operation, and for three days progress was all that could be desired. On the fourth day collapse symptoms appeared, there was a little vomiting, and the patient died thirty-six hours after the onset of these symptoms.

POST-MORTEM EXAMINATION (*Fig. 283*).

On palpation of the pancreas, several hard fixed nodules were felt in the posterior part of the head and between it and the duodenum. On opening the latter, the biliary papilla was found considerably enlarged and very prominent, projecting about 1 cm. from the surface of the intact mucous membrane of the bowel.

The tip of a No. 6 rubber catheter passed easily into the papilla for a distance of a little less than 1 cm.; by pressing on the head of the pancreas a little thick brown bile could be expressed from the orifice; a probe encountered obstruction just inside the ampulla, but could be passed with some difficulty for several inches into the common bile-duct. On opening up the papilla, a well-formed ampulla was exposed, projecting into which was a spherical mass of new growth, 1·5 cm. in diameter, arising by a broad base of attachment from the posterior wall of the termination of the pancreatic duct. The growth half filled the ampulla, which appeared dilated; its mucous membrane was not

infiltrated. There was no infiltration of the wall of the common duct, which was almost completely occluded, and deviated to one side by pressure of the growth. The growth was white, hard, and sessile, and its surface slightly roughened. The duct of Wirsung, the common bile-duct, and the hepatic ducts were considerably dilated; the cystic duct appeared rather narrower than normal. Thick, dark, deep-brown fluid was present in the common bile-duct. No calculi were found.

An accessory pancreatic duct was found opening separately into the duodenum. Partly embedded in the posterior portion of the head of the pancreas, and between it and the second part of the duodenum, were four enlarged fixed lymphatic glands, the largest 1.5 cm. in diameter.

The gall-bladder was enlarged (long axis 15 cm.), its walls were slightly thickened and rather rigid; the mucous membrane, after washing off some loose clot, was white, smooth, and rather shiny. The cavity was filled but not distended by recent clot from hæmorrhage about the operation site. The anastomosis was firm and watertight. The liver was olive-green in colour, slightly shrunken, and very flabby. The surface was smooth. The intra-hepatic ducts were considerably dilated and contained thick brownish-yellow bile. The portal canals were prominent and the lobular pattern very distinct, each lobule showing as a deep green spot fading to yellow-brown at its periphery. The structure was homogeneous throughout; the organ appeared anæmic; no suggestion of gross hepatic necrosis. The spleen was small and shrunken, the capsule wrinkled, and the pulp pale and firm. The pancreas showed no obvious naked-eye abnormality except for dilatation of its main duct.

PATHOLOGICAL HISTOLOGY.—*Growth.*—Sections show large isolated masses of undifferentiated spheroidal-celled carcinoma lying in rather dense fibrotic stroma. There is no tendency to tubule formation; the cells are large, spherical, and in close opposition. There is a slight superficial ulceration (microscopic). The cell type is very constant; no columnar or goblet cells seen.

Gland.—No trace of lymphatic tissue present. Normal tissue is replaced by massive solid and anastomosing alveoli composed of spherical cells of the

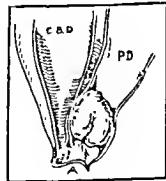
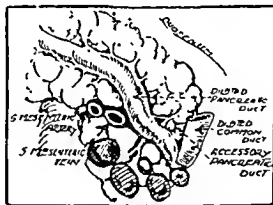
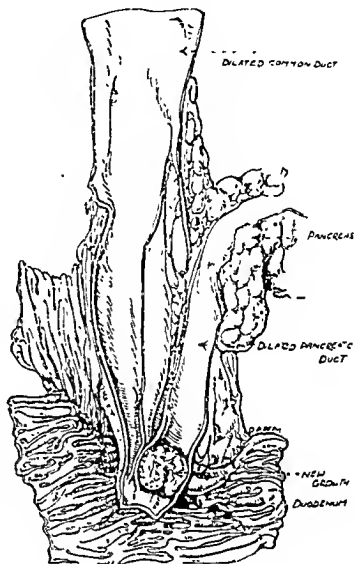


FIG. 283.—Carcinoma of the ampulla of Vater originating in the termination of the pancreatic duct. The left lower figure shows the pancreas from behind, with position of enlarged glands.

same type as in the primary growth (Fig. 284). Where the stroma is more abundant there is considerable lymphatic permeation. Unlike the primary growth, there is occasional tubule formation in the metastases.

Pancreas.—Sections show considerable dilatation of the larger ducts, with flattening, and in some places localized hyperplasia and papillary projection, of the lining epithelium. There is a general interlobular pancreatitis of moderate intensity, most marked about the larger ducts. In those lobules bordering on the main connective-tissue septa small groups of tubules are isolated by fibrosis, but this has not penetrated into the more deeply placed lobules, the acini and islets of which show no special change. The gland shows no atrophic changes, and the appearances seen are apparently secondary to obstruction of the duct system only.

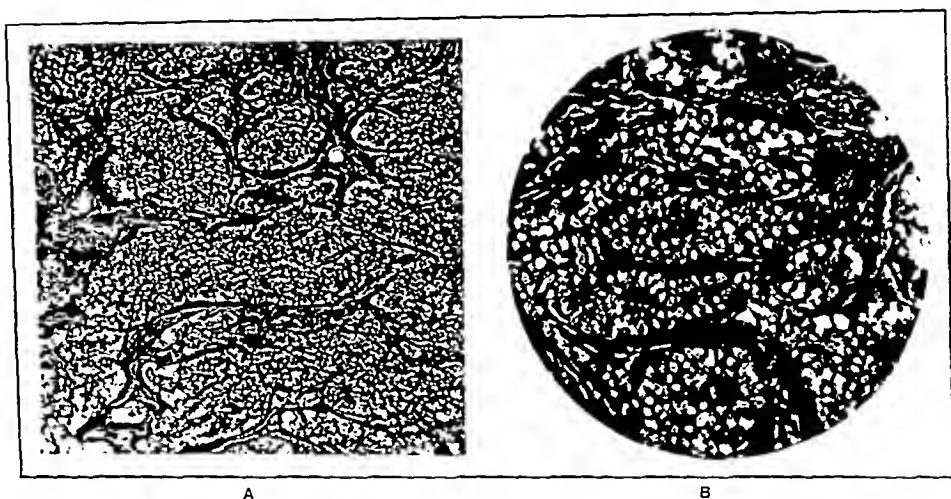


FIG. 284.—Retropancreatic gland (juxta-ampullary carcinoma of Wirsung's duct). A, Low-power view showing massive columns of spheroidal cells which entirely replaced the lymphatic tissue of the gland. B, High-power view, showing undifferentiated spheroidal-celled carcinoma.

The primary growth was of the same type.

Liver.—The larger bile-ducts are much dilated and their epithelium is flattened and desquamating. A moderately intense inflammatory cell-exudate of lymphocytes and a few plasma cells surrounds them. The medium-sized ducts are proportionately less dilated, but their portal canals contain more cells, and in addition many nuclear fragments, while fibroblasts are scanty. The dilatation of the ducts in the smallest portal canals is slight and their epithelium little altered, but many of these ducts contain plugs of dark green or yellow-brown bile. Almost every liver lobule shows an area disposed around the central vein where bile stasis and necrosis of the hepatic parenchyma are obvious. This area usually occupies the inner third of the lobule and in some cases stretches across it to join similar areas in adjacent lobules. The outer two-thirds of the lobules are often almost normal-looking except that the bile capillaries are full. In the degenerate central areas the liver-cell

columns are broken and the cells isolated and filled by pigment. Many of these cells have pyknotic nuclei; in some the nucleus is fragmented or absent and the cell body only faintly outlined, whilst masses of pigment and nuclear fragments occupy the place of others.

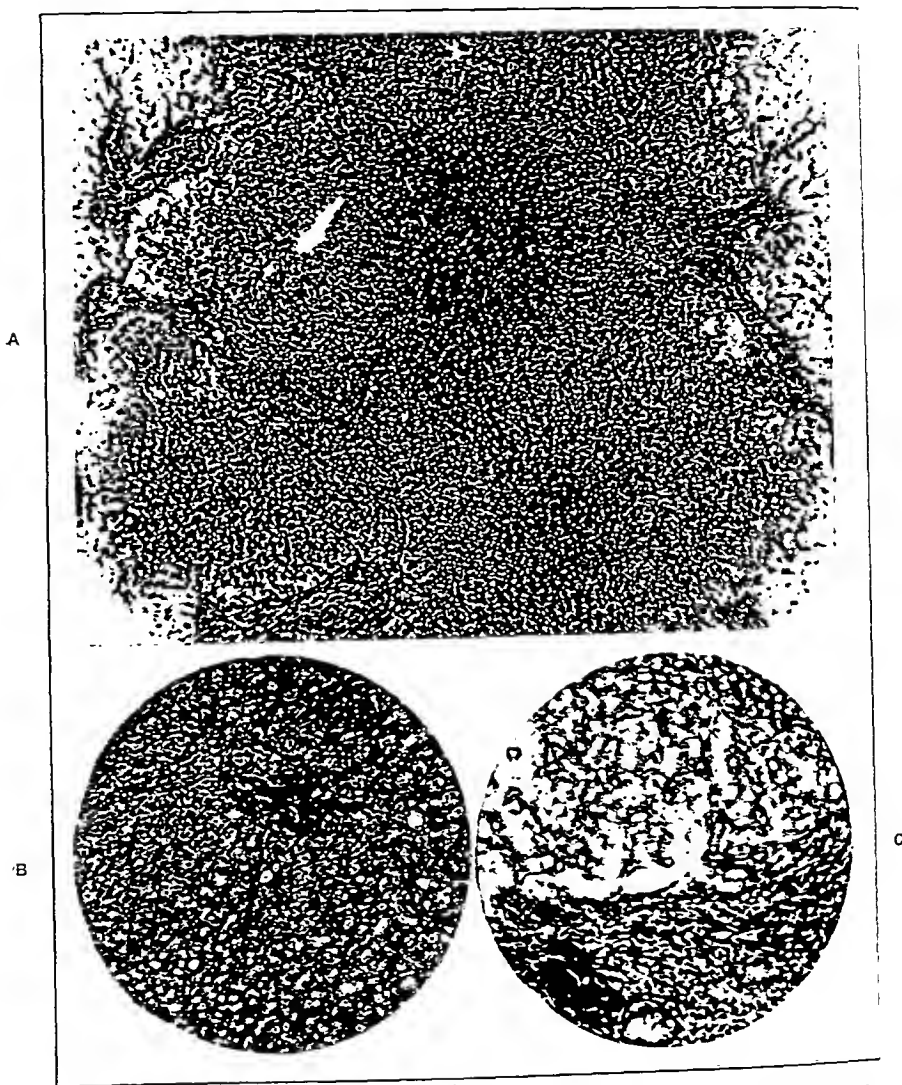


FIG. 285.—Liver from case of juxta-ampullary carcinoma of pancreatic duct, showing atrophy from extra-hepatic biliary obstruction. A. Low-power view: lobules show centrilobular pressure atrophy of parenchyma. B. Atrophic parenchyma from centre of a lobule. C. Fairly well-preserved cells of edge of lobule.

Large masses of bile-pigment lie free in the central area of the majority of the lobules. In some lobules there are many centrally-placed phagocytic cells with large, clear, well-staining nuclei, containing pigment in their cytoplasm. The liver-cell necrosis is seen in the neighbourhood of the central vein of the

majority of the lobules and is present in all sections. The histological changes (*Fig.* 285) are those often found in association with complete aseptic obstruction of the common bile-duct. The total amount of necrosis of liver parenchyma is considerable and regeneration absent.

SUMMARY.

A previously healthy man of 48 died after an illness of three and a half months, characterized by deepening jaundice, without definite intermission, and increasing weakness.

Post-mortem examination showed a sessile nodule of carcinoma the size of a pea arising in the wall of Wirsung's duct just above the dilated ampulla of Vater, and obstructing the common bile-duct by lateral pressure. Metastases were present in the retropancreatic glands. The nodule of growth was the average size and shape of the enlarged glands, and situated so near them that it was extremely difficult to distinguish between the growth and the enlarged glands by palpation of the duodenum at the operation. The gall-bladder was found distended by clear colourless fluid at operation.

A functioning accessory pancreatic duct was present. The Van den Bergh reaction and a stool analysis did not materially assist the clinical diagnosis. Death was probably due to widespread pressure atrophy of the liver cells, secondary to obstruction of the common duct.

The case reported presents the following points of interest, apart from the rare anatomical localization of the tumour :—

1. Absence of definite intermissions in the intensity of the jaundice.
2. Concealment of the enlarged gall-bladder by the swollen liver—an apparent exception on clinical examination to Courvoisier's law.
3. The retropancreatic glandular metastases were of the same size and consistence as the miniature growth itself: this was therefore mistaken for an enlarged gland, and the duodenum was not opened.
4. There was complete sequestration of the gall-bladder, which contained colourless watery fluid: the grave significance of this is borne out by the extensive atrophy of the liver parenchyma found post mortem.
5. The relatively benign nature of the tumour is striking: there was no infiltration of the mucous membrane of the bowel, and the lymphatic metastases were limited to the retropancreatic set of glands.

I am indebted to Mr. Clifford Moore, Surgeon to the General Hospital, Bristol, for permission to use his clinical records.

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A METHOD OF TREATMENT OF FRACTURE OF A SINGLE CONDYLE OF THE FEMUR WITH DISPLACEMENT BACKWARDS OF THE DISTAL FRAGMENT TO THE POPLITEAL SPACE.

By LIONEL SUTCLIFFE, CHESTERFIELD.

THE first surgeon to describe a fracture of a single condyle of the femur was Bichat in 1850, but he confined himself to pointing out its possibility. Malgaigne's¹ would appear to be the earliest description of a series of cases, and he, in 1859, confined himself to three only, which he had seen and treated personally. It is interesting to note that he suggested—for cases with little or no displacement—the best treatment to be rest in the extended position of the joint over a cushion after reduction. The application of leeches and evaporating lotion to reduce the swelling followed, and finally he surrounded the joint with a trough of strong pasteboard, previously softened in warm water, in order to conform to the contours of the parts.

The rarity of this condition, together with the considerable barrenness of authoritative information, either with regard to such an injury or to its treatment, has led me to believe that the following remarks may suggest a method of procedure of value in such cases. Most text-books dismiss a fracture in this region airily, by stating that they are all very rare, but that small chips of the condyle may be separated from the femur in certain cases of injury to the knee-joint.

On Feb. 11, 1924, T. E., a male, age 20, a collier, was admitted to the Chesterfield Royal Hospital under my care, with an injury to the right knee-joint. Whilst playing football on Feb. 9, the patient caught his right foot between another player's legs, and fell heavily to the ground, twisting his leg as he did so. He had been unable to put any weight on the limb since, and all movements of the joint were painful. Examination disclosed a considerable amount of swelling around the whole joint, which was mainly extra-capsular. No floating of the patella could be detected, and both patella pouches showed fullness. The position of the joint was one of complete extension together with eversion of the leg. Limitation of flexion was absolute. Crepitus was elicited by gentle friction of the condyles. Increased lateral movement of the tibia and fibula with the femur was present. There was a fullness in the popliteal space, most marked on the inner side. The X rays showed a fracture of the medial condyle of the femur, with complete avulsion, and displacement backwards to the popliteal space.

Such were the history, clinical signs, and X-ray report two days subsequent to his injury. The more natural condition to follow such an injury in a patient of this age is the separation of the lower epiphysis or a T-shaped fracture of

both condyles. It is rather remarkable that, although this patient is 20 years old, the femur elected to fracture higher up, rather than follow the more natural course of separating at the epiphyseal junction.

Roberts and Kelly² suggest that forced abduction or adduction of the knee, twisting of the leg, or direct force transmitted through the head of the tibia toward the involved condyle may cause this fracture. From a study of the history of this case, it appears clear that a combination of all these

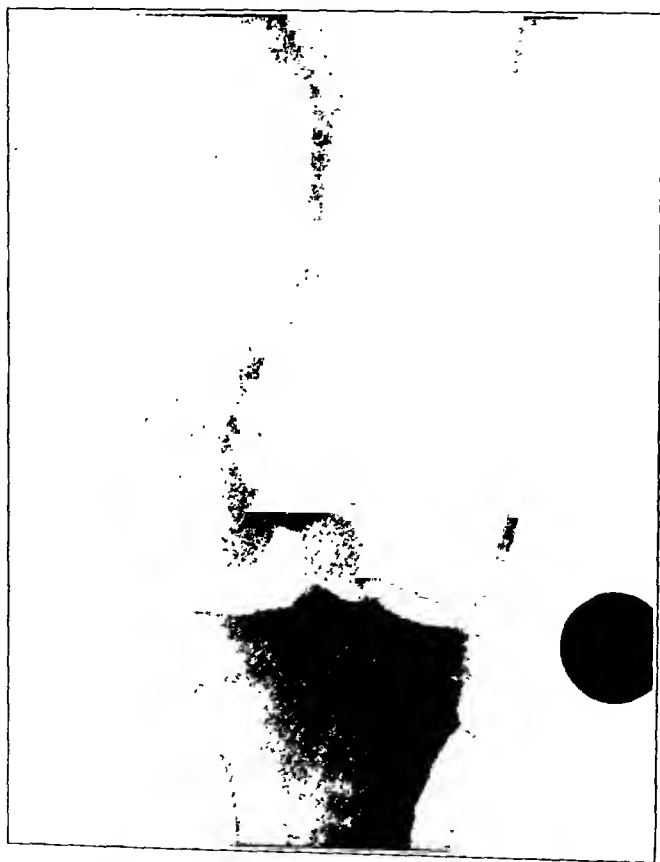


FIG. 286.—The fracture and displacement before operation.

factors was the etiological feature in fracturing the condyle. Abduction and twisting, at the moment the patient's leg was between the other player's legs, and direct violence when he was forcibly thrown to the ground.

Although no precedent could be found, it was decided that conservative treatment by manipulation and splinting was contra-indicated, (1) owing to the amount of effusion, with the consequent impossibility of accurate reduction, and (2) owing to fear of damage to the popliteal vessels from the forcible reduction of the backward displacement of so large a fragment.

Therefore on Feb. 14, 1924, a longitudinal incision, 4 in. long, was made, under general anæsthesia, on the medial aspect of the patella, which was deepened down to the vastus medialis. There was a distinct rent in this muscle, which was cleared of blood-clot, and increased upwards and downwards for the length of the incision. The lower end of the femur, external to the capsule, was exposed through the vasti lateralis and intermedius. It was apparent here that the tendinous expansions from the vasti lateralis and



FIG. 287.—The fracture and displacement before operation.

medius, which should strengthen this portion of the capsule, were very poorly developed. The capsule was incised at right angles to the skin incision, clots and serum were sponged out, and the proximal fragment was sought for and isolated. The condyle was then discovered completely separated from the femur, turned round on itself from without inwards, and displaced upwards and backwards to the popliteal space. The line of fracture ran obliquely downwards and inwards from the femoral shaft to the intercondylar space, and was entirely intracapsular.

There appeared so little likelihood of a satisfactory union resulting if left in position after reduction that it was decided to plate the fragments. A small Lane's plate with three screws was used for this purpose, one screw driven home below the line of fracture on to the condyle, and two screws above the line of fracture on to the femur. After careful cleansing of the joint by dry swabbing and complete hæmostasis, the capsule was closed by interrupted catgut sutures, the rent and incision in the muscle being closed similarly. without drainage, and after skin suture the joint was put up on a double inclined plane, at an



FIG. 288.—Condition of the fragments after plating.

angle of 45° . After fourteen days the skin sutures were removed, and the wound had healed by first intention.

Gentle massage for twenty minutes daily was commenced on the fifteenth day, and carried on for one week. Passive movement was added at the end of the first week's massage, and then active and passive movement instituted two weeks after removal of the skin sutures.

The patient remained in hospital for eleven weeks, and was discharged cured, with a normally functioning knee-joint, but with instructions not to place full weight on the knee for another four weeks. He can now walk

normally without aid, complete range of movement is present in the joint, and there is no undue lateral movement.

The series of X-ray photographs (*Figs. 286-289*) explain themselves.

Stimson³ affirms all fractures of a single condyle to be rare, and does not describe any case with complete avulsion. He says that the displacement is slight and—most important—the connections are untorn. Non-union of the fragment and suppuration of the joint, with or without a fatal termination, may result, in his experience, from conservative non-operative treatment.

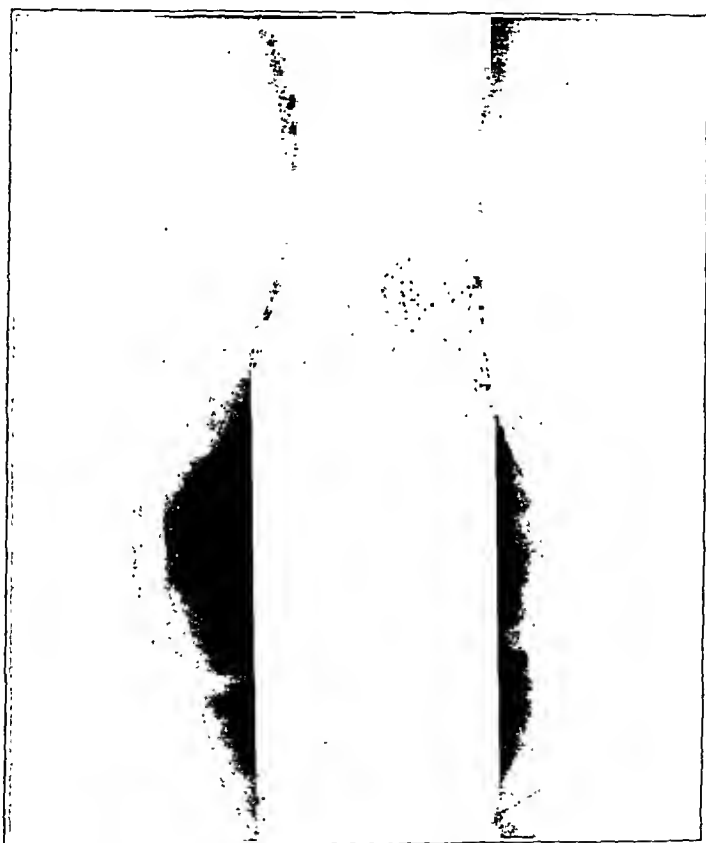


FIG. 289.—Condition of the fragments after plating.

He recommends reduction and immobilization, with the knee fully extended, owing to the fact that the lateral ligament is usually intact, and will in the extended position be tense, and thus aid fixation.

A. H. Crosby⁴ reports a case in which the ununited fragment was removed six months after injury, and the patient made a complete recovery.

Roberts and Kelly refer to manipulative treatment of the fragments and immobilization in splints, but suggest no operative procedure. I am confident that in this case imperfect reduction owing to the laceration of the lateral ligament, danger to the popliteal vessels, and an impaired function of the joint,

FRACTURE OF SINGLE CONDYLE OF FEMUR 455

would almost certainly have resulted from manipulation without fixation by open operation.

CONCLUSIONS.

1. An intracapsular fracture of a condyle of the femur can be plated.
2. The method of approach to the joint was justified by the traumatism caused by the accident.
3. The risk of an open operation was justified by the age of the patient and the importance to him of a sound knee, because of his occupation as a miner.

My sincere thanks are due to Dr. Morrell for his help in preparing the X-ray films, and to Dr. Webster for his unremitting care and assistance in the after-treatment.

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ON RETROPERITONEAL HERNIA : WITH A REPORT ON THE LITERATURE.

By A. RENDLE SHORT, BRISTOL.

IN 1906 a monograph was published by Moynihan classifying the various types of retroperitoneal fossæ in which a hernia has been found, and giving the literature up to that date. In 1915 the present writer took advantage of a case occurring in his practice to report on the recorded cases from 1906 to that time. Another patient suffering from this rare and interesting condition has lately been under his care, and as a further period of nine years has elapsed and some new types of hernia have been described, it seems a suitable opportunity to bring the literature up to date and to summarize it. He will not on this occasion describe cases which have been unsuspected during life and discovered post mortem, but confine himself to those in which there were symptoms and, usually, an operation.

Case.—C. B., male, age 20, admitted to the Bristol Royal Infirmary in August, 1923, suffering from intestinal obstruction. The history given was that he had been subject to numerous attacks of the same type all his life, having had forty or fifty in all. They usually lasted about two or three days, and then passed off. In each attack there was abdominal pain, vomiting, stoppage of the bowels, and some distention. Nothing special was to be made out on examination of the abdomen, except some general distention of the small-gut type. I waited a day or two to see if it would pass off, but as it did not, I operated on Aug. 18, and found that many feet of jejunum were herniated into a typical left paraduodenal fossa of Landzert, showing the inferior mesenteric vein in the free border of the sac. The coils of gut were withdrawn, but as the condition was bad, and the gut very distended, no attempt was made at that time to close the mouth of the sac. There was some suppuration of the abdominal wall, but the patient recovered, and had no further attacks. On Sept. 29, 1923, I operated again to close the sac, but found that the mild adhesive type of peritonitis which accompanied the suppuration of the abdominal wall had made a recurrence impossible by adhesions of the jejunum and plastic closure of the mouth of the sac.

Brief Description of the Retroperitoneal Fossæ.—The frequency of occurrence of the principal fossæ is given as follows by Desjardins :—

Inferior duodenal fossa of Treitz	..	60 per cent
Combined inferior and superior ditto (<i>Fig. 290</i>)	30	..
Superior duodenal alone	.. ..	5 ..
Left paraduodenal fossa of Landzert	.. ..	2 ..
Mesocolic fossa	.. ..	2 ..
Right mesentericoparietal fossa of Waldeyer	1	..

Of these, the superior and inferior duodenal fossæ do not appear to be of pathological importance.

The paraduodenal fossa of Landzert, or left duodenojejunal fossa, lies to

the left side of the fourth part of the duodenum. the opening looks to the right, and the inferior mesenteric vein runs in the free border (*Fig. 291*).

The *mesentericoparietal fossa of Waldeyer*, or right duodenojejunal fossa, lies in the first part of the mesentery of the jejunum, below the duodenum.

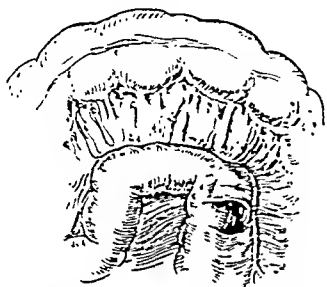


FIG. 290.—Combined superior and inferior duodenal fossae.

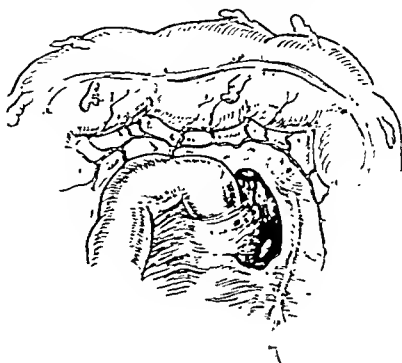


FIG. 291.—Paraduodenal fossa of Landzert, with inferior mesenteric vein in neck of sac.

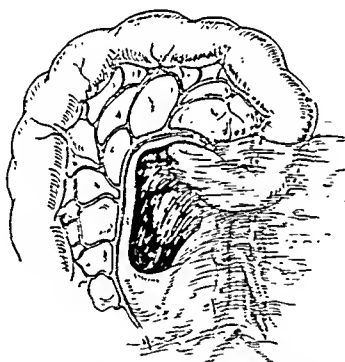


FIG. 292.—Mesentericoparietal fossa of Waldeyer. Shows the superior mesenteric artery in the neck of the sac.

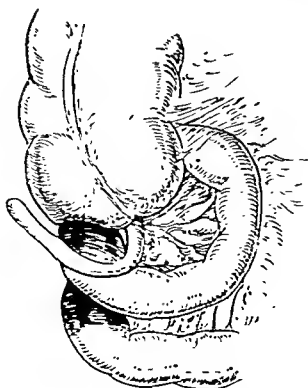


FIG. 293.—Retrocolic fossa (Pribram's case)

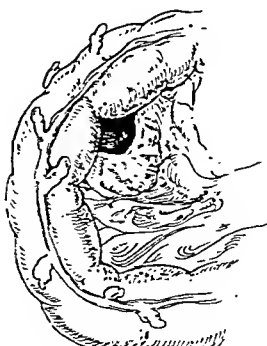


FIG. 294.—Intersigmoid fossa (Macholl's case).

The opening is to the left, and the superior mesenteric artery runs in the free edge (*Fig. 292*).

The *retrocolic fossa* lies behind the cæcum and ascending colon, with the mouth looking downwards. *Fig. 293*, illustrating this fossa, is redrawn from Pribram's case.

The *ileo-appendicular fossa* lies between the abnormal ileo-appendicular fold (so-called bloodless fold of some authors) and the mesentery of the appendix; the termination of the ileum lies above it. The opening looks to the left and downwards.

The *fossa ileocecalis of Hartmann* lies between the mesoappendix and the attachment of the mesentery to the iliac fossa running from the ileocolic angle to the posterior and inner aspect of the cæcum. The fossa looks downwards.

The *intersigmoid fossa* is situated in the mesosigmoid, on the left-hand side, close to the attachment of the mesosigmoid to the posterior wall. The opening looks downwards. It is present in the majority of children. But in some cases it lies within the layers of the mesosigmoid, as in the example shown in (*Fig. 294*), re-drawn from Maeholl's case, where the fossa lies much nearer to the bowel than to the parietes.

Andrews, in a recently published paper, argues that so-called retroperitoneal hernia is really due to a developmental abnormality, and not to an acquired condition.

Table I.—CASES OF RETROPERITONEAL HERNIA PRODUCING SYMPTOMS
RECORDED SINCE 1914.

DATE	REPORTER	SEX AND AGE	DESCRIPTION	TREATMENT	RESULT
Hernia of Left Paraduodenal Fossa.					
1914	Davis	M 48	Symptoms of strangulation, globular swelling felt. One previous attack	Reduction	Died
1916	Pringle	M 40	Recurrent attacks of obstruction. Tumour felt	Partial reduction; short-circuiting	Cured
1916	Wagner	F 14	Recurrent attacks; obstruction	Reduction	Cured
1917	Bramlett and Ashhurst	M 47	Recurrent pain; acute obstruction	Reduction	Died
1917	Filauro	F 60	Acute obstruction; cyst-like swelling	Reduction	Died
1917	Nixon	M 30	Recurrent abdominal pain	Reduction	Cured
1918	Grad	F 52	Abdominal pain	Reduction	Cured
1920	Haberer	F 62	Acute obstruction	Reduction	Cured
1920	Harttung				
	1.	M 49	Acute obstruction	Reduction	Cured
	2.	M 44	Acute obstruction	Big resection of bowel	Cured
	3.	M 54	Acute obstruction	Enterotomy	Died
1920	Hayes	F 68	Chronic obstruction	Reduction	Cured
1921	Crescenzi	F 43	Acute obstruction	Reduction	Cured
1923	Thomson	F —	Acute obstruction	Reduction	Cured
1923	Rendle Short	M 20	Many attacks of obstruction	Reduction	Cured
Hernia of Mesentericoparietal (right duodenal) Fossa.					
1924	Novak & Sussman	M 34	Acute obstruction	Reduction	Cured

Continued on next page.

Table I.—CASES OF RETROPERITONEAL HERNIA PRODUCING SYMPTOMS
RECORDED SINCE 1914—*continued.*

DATE	REPORTER	SEX AND AGE	DESCRIPTION	TREATMENT	RESULT
Retrocolic Hernia.					
1918	Finsterer	M 33	Discovered strangulated, in course of operation for strangulated inguinal hernia	Reduction	Cured
1920	Pribram	M 51	Acute obstruction	Resection of 235 em. of ileum	Cured
1921	Zoeppfel	M 18	Found during operation for appendicitis. As big as child's head	Not reduced	Cured
1923	Copenhaver	M 25	—	—	Died
Hernia into Foramen of Winslow.					
1918	Rawlence	M 18	Acute obstruction; tympanitic tumour	Reduction	Cured
1919	Engstad	M —	Acute obstruction; tense mass in epigastrium	Reduction	Cured
1919	Schmülinsky	F 65	Obstruction for 3 weeks. Cæcum and ileum in foramen	Reduced	Cured
1923	Copenhaver	F 56	—	—	Died
Intersigmoid Hernia.					
1915	Black	F 34	Followed a fall; signs of partial obstruction	Reduction	Cured
1918	Taylor	M 27	Acute obstruction	Reduction	Cured
1923	Carling & Jones	M 47	Acute obstruction	Reduction	Cured
Hernia through the Transverse Mesocolon.					
1919	Pringle				
	1.	F 55	Symptoms like gastric ulcer. Bowel entered lesser sac through transverse mesocolon, and escaped through gastrohepatic omentum	Reduction	Recurred & died
	2.	F 26	Ditto	Reduction	Cured
	3.	M 36	Followed old gastrojejunostomy. Bowel entered by transverse mesocolon, and escaped through gastrocolic ligament	Reduction	Cured
	4.	F 35	Had also a gastric ulcer	Gastro-jejunostomy	Cured
Hernia into Broad Ligament.					
1917	Fagge	F 61	Acute obstruction	Reduction	Relieved
	"	F 49	Acute obstruction	Reduction	Cured
1920	Barr		Acute obstruction		
1924	Pidcock	F 35	Acute obstruction	Resection of gut	Cured
Anomalous Retroperitoneal Herniæ.					
1914	Primrose	M 60	Found in course of operation. Sac entered beneath middle colic artery	Reduction	Cured
1920	Olmsted	F 25	Symptoms like cholecystitis. Sac entered beneath left colic artery	Reduction	Cured
1923	Carling & Jones	M 31	Recurrent attacks of pain. Sac entered beneath ileocolic artery	Reduction	Cured
1924	Pidcock	M 37	Acute obstruction. Sac entered beneath right side of superior mesenteric artery	Reduction	Cured

Recorded Cases of Retroperitoneal Hernia producing Symptoms during Life.—

LEFT PARADUODENAL FOSSA.—Moynihan gives 8 case reports of patients successfully operated on (by Sonnenberg, Tubby, Priestly Leach, Narath, Haberer, Lawford Knaggs, McArthur, and Sherren). At least 10 others died, with or without operation.

The author in 1915 reported 10 further cases. These included those operated on by Vautrin (2), Crisler, Heller, Felten, Von Holst, Obrastzow, Pikin, Gobeit, and Pybus. In Priebatsch's case, the patient died of obstruction, but there was no operation. All the others recovered except Obrastzow's. In Barker's case the condition was discovered accidentally at an operation for cancer of the stomach.

The present report adds 15 fresh cases, whereof 11 recovered after operation, and 4 died.

The total recoveries therefore amount to 27, and the deaths to 16. No doubt many fatal cases go unreported, and there are some further recorded cases scattered about in literature which is inaccessible here.

RIGHT OR MESENTERICOPARIETAL FOSSA (Waldeyer's).—Moynihan gives 1 case successfully operated on (Nemmann's), and at least 3 others dying of the condition (Barr's, Paton's, and Zwaardemaker's). The author added 1 case (Haasler's), which was operated on but died of obstruction. Four more old cases (Quénu, Clarke, Rose, Selby) have been added to the list by Nagel; all died. Also 3 more recent cases, described by MacAllum and Miller in 1908 (male, aged 41, died after operation); Mueller in 1911 (male, aged 47, died after operation); and Carson (male, aged 29, recovered after operation). To these Novak and Sussman add an eighth, a man, aged 34, who recovered. Thus we know of 3 recoveries and 10 deaths.

PERICÆCAL FOSSÆ.—The commonest of these is the *retrocolic fossa*. In Moynihan's series, there were 6 patients with symptoms, described by Rieux, Aschoff, Mansell Moullin, Atherton, Neumann, and Funkenstein. Of these, 4 died, and 2 recovered (Aschoff, Neumann). To these the present writer added 3, reported by Matthews, Marsh, and Ransohoff. Of these, Matthews' patient died of obstruction without operation; Marsh's and Ransohoff's were cured by operation.

A valuable paper by Pribram contributes 5 more old cases, between 1896 and 1911, all operated on and recovering (Korte, Bonsdorff, Marion, Joas, Krinsky). Since 1914, 3 further cases have been recorded by Pribram, Zoepffel, and Finsterer. All these were successfully operated on. Thus the retrocolic hernias recovering after laparotomy number 12, with 5 reported deaths. Copenhagen mentions another fatal case at the Mayo Clinic, but without details.

Hernia into the *ileo-appendicular fossa* has been described on several occasions, of which Moynihan accepts 5 in which obstructive symptoms were present (cases of Little, Partridge, Nasse, Riese, and MacEwan.) The last two were operated on and recovered; Nasse's case was also operated on, but died. We have no further cases to add.

Hernia into the *fossa of Hartmann* is rare; the only known case is that of Snow, which was fatal. A case found post mortem has been described by

Fleming, but it produced no symptoms during life. The present writer in 1915 described a personal case, in which the entrance to the sac lay to the outer side of the cæcum, looking to the right (*Fig. 295*). This patient recovered after operation.

FORAMEN OF WINSLOW.—In Moynihan's series, there were 9 cases with symptoms (described by Blandin, Moir, Majoli, Squire, Treves, Neve, Adjaroff, Delkeskamp, and Mori). The last 5 were operated on; 2 recovered, in the hands of Neve and Delkeskamp.

In 1906, Jeanbeau and Riche published a monograph on the subject, and reported additional cases from the literature. Their own case is rather doubtfully an example of this condition, and proved fatal though operated on. In addition to this and to those in Moynihan's list, they record 6 cases operated on (by Gangolphe, Rehn, Picado, Stecchi, Reynier, and Marten). Of these, all were fatal except Marten's. Novello published a fatal case, not operated on.

Between 1906 and 1915, I found records in the literature of 4 more, reported by Carwardine, Haw, Morton, and Sinclair. Sinclair's patient recovered. Haw's patient died without operation; the other two were explored.

Since 1914, 3 further cases have been published, all operated on and all recovering (by Rawlence, Engstad, and Schmilinsky). Thus altogether there are 24 cases: 6 were not operated on but died of strangulation; 11 died in spite of operation; and 7 survived. Copenhaver mentions a fatal case at the Mayo Clinic, but gives no details.

INTERSIGMOID HERNIA.—Moynihan rejected the oft-quoted case of Jomini, but allowed 2 examples of the condition (under the care of Eve and Eccles). Both died, the first without and the second with operation. To this Coley's case is to be added, which also died without operation.

In addition to these, 2 examples have come to light which were overlooked, both published in 1911, by Krall and Macholl respectively. Krall's case was a man, age 33, suffering from subacute intestinal obstruction, operated on and cured. Macholl's patient, with more acute symptoms, died after laparotomy (*see Fig. 294*).

Since 1914, 3 cases have been published, all cured by operation. One of them (Black's) followed a fall, and showed chronic obstructive symptoms; the diagnosis was suggested before operation. The other two cases (Taylor, Roek Carling and Jones), had acute obstruction.

Thus we know of 8 cases, of which 4 were saved by laparotomy.

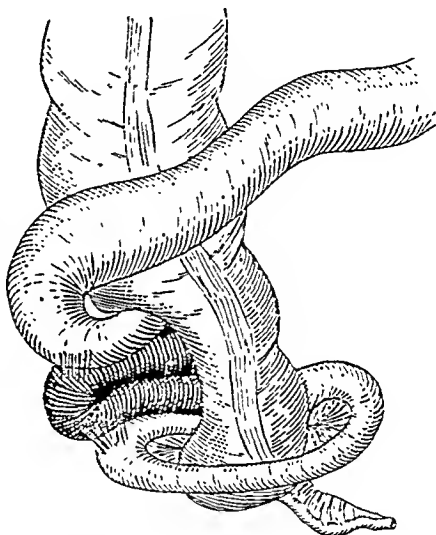


FIG. 295.—Fossa external to the cæcum.
(Author's case.)

HERNIA THROUGH THE TRANSVERSE MESOCOLON.—In this condition, which is not in quite the same category as those which we have been considering, the hernia does not pass into a congenital peritoneal sac or one formed by stretching, but there is a slit or tear in the transverse mesocolon, on account of its tenuity. It is well known, of course, that rents may occur in the mesentery, as a result of grave trauma, but we shall not deal with such. In the described cases of hernia through the transverse mesocolon, there was no history of trauma.

Moynihan does not give any examples of this variety, unless Astley Cooper's stillborn infant can be classed here.

The writer, in his previous communication, quoted 4 examples (those of Mayo (2), Stolzenberg, and Halpenny).

In 1919, Pringle described 4 more, but as one of these had had a previous gastrojejunostomy it does not come into our classification. In his first two cases, the symptoms resembled those of gastric ulcer (in the second there had been hæmatemesis); but at operation a hernia was found of small intestine passing through the transverse mesocolon into the lesser sac behind the stomach, and emerging through the gastrohepatic omentum. The bowel was extracted by operation, with success, but one of the cases recurred and died. In the fourth case, a gastric ulcer was present, but the jejunum was herniated into the lesser sac and emerged through the gastrocolic omentum. Gastrojejunostomy was performed, and a good result obtained.

HERNIA INTO THE BROAD LIGAMENT.—No record of this condition is known to us prior to 1917, when Fagge described 2 cases, both coming under treatment for acute intestinal obstruction. In the first, there was a loop of ileum passed from behind forward into a hole in the left broad ligament below the ovarian ligament. No fossa is recognized by anatomists in this situation. The patient recovered after laparotomy and reduction, but had further trouble from adhesions. In the second case, the coil of ileum was strangulated in a pouch above the ovary on the right side, entering from behind forwards. This case was cured.

Barr has described another example, of which details are not accessible to me. A fourth case is recorded by Pidcock. The woman had been delivered of a child a fortnight before, and was seized with acute intestinal obstruction. The obstructing band was the round ligament, and the fossa lay below it. Eight feet of gut had to be resected, and there were suppurative troubles, but she eventually recovered.

ANOMALOUS RETROPERITONEAL HERNIÆ.—A case of hernia into Fromme's fossa, which lies behind the symphysis pubis and in front of the bladder, was recorded in 1908, and recovered. Possibly there are two other cases recorded by Trůka, but the paper is not available.

Primrose relates finding, during an operation for hour-glass stomach, a large retroperitoneal hernia occupying a thin flabby sac chiefly in the left lumbar region, extending deep into the pelvis, with the opening bounded anteriorly by the middle colic artery, which arose from the right common iliac artery, and proceeded up to the transverse colon. As there were no symptoms, nothing was done. In Olmsted's case the symptoms were diagnosed to be due to cholecystitis, but laparotomy revealed instead a large

flaccid retroperitoneal hernia extending into the pelvis, which contained more than half the small intestines, with the ascending branch of the left colic artery lying in the free falciform edge of the sac. The patient was cured.

Rock Carling and Jones described a case in which there were recurrent attacks of pain, and at operation it was discovered that a loop of ileum had passed into a pouch in the terminal part of the mesentery of the ileum. There was a slit-like aperture 5 inches long, with the ileocolic artery to the right and the last branch from the superior mesenteric to the ileum to the left. A very similar condition was described by Treves in his 1885 Hunterian Lecture. The patient made a good recovery.

In Pidecock's case, the patient was operated on for acute obstruction, and a coil of small intestine was found strangulated in a pouch in the root of the mesentery, entering from the right, having the superior mesenteric artery in front of the opening, and the structures of the posterior abdominal wall behind. It was analogous to a mesentericoparietal hernia of Waldeyer, but entered from the right side of the mesentery instead of the left. Operation was successful.

It is worthy of notice, in most of the varieties of internal hernia, what an important part is played in the production of the sac by vascular bands. These offer a resistance along a particular line, and the peritoneum gets pushed in beneath this line. Thus in the right and left paraduodenal herniæ, the superior mesenteric artery and inferior mesenteric vein respectively act in this way, and the anomalous cases just mentioned show the same feature.

Clinical Features of Retroperitoneal Hernia.—When retroperitoneal hernia produces sufficient symptoms to become of clinical importance, the picture may conform to one of three types: (1) Acute strangulation; (2) Recurrent subacute strangulation; (3) Palpable tumour formation.

If the symptoms and signs are merely those of acute intestinal obstruction, exact diagnosis is of course impossible. In a certain number of the cases, however, as in that which stands at the opening of the present communication, the diagnosis is possible, and, *inter alia*, was made in this particular instance. My patient had had forty or fifty attacks of subacute intestinal obstruction, which were in the habit of clearing up after two or three days. This could scarcely be due to any other cause.

Again, either during an attack of acute obstruction, or apart from any severe symptoms, there may be a palpable tumour in the abdomen, which has several times been mistaken for an ovarian or pancreatic cyst. The characters of this tumour are fairly distinctive, as Moynihan points out. It is limited to a definite area of the abdomen; it is resonant on percussion; distinct gurgling sounds may be heard over it on auscultation; its size and tension vary with the symptoms.

The clinical picture in patients with a hernia through the transverse mesocolon is quite different, resembling those of gastric ulcer.

Treatment.—The operative treatment of these cases may be very easy, or difficult to impossible. As the records show, the results during the past ten years have been much more favourable than in the earlier cases, no doubt

on account of earlier operation. If the gut is already gangrenous, it must of course be resected, and even so several have recovered. Usually the patient is too ill to attempt a closure of the mouth of the sac; in favourable cases this ought to be done, but with due regard for the vessels so often met with in the neck of the sac. If reduction is impossible, it is generally feasible to cut the neck of the sac in an avascular region. When the hernia involves the foramen of Winslow, of course this cannot be done, and the suggestion made by Moynihan is probably the most hopeful; he advises tearing into the lesser sac through the gastrocolic omentum, and incising and emptying a coil or two of the incarcerated gut. After this has been done and the incision in the gut sutured, it will perhaps be possible to withdraw it through the foramen.

TABULAR SUMMARY.

The following cases of retroperitoneal hernia producing symptoms during life are on record, besides a few published in inaccessible communications:—

NATURE OF THE HERNIA	TOTAL CASES	DIED		RECOVERED AFTER OPERATION
		WITHOUT OPERATION	AFTER OPERATION	
Left paraduodenal fossa	43	—	16	27
Right ditto	5	3	1	1
Retrocolic fossa	17	1	4	12
Ileo-appendicular fossa	5	2	1	2
Fossa of Hartmann	1	1	—	—
Other pericecal fossæ	1	—	—	1
Foramen of Winslow	24	6	11	7
Intersigmoid fossa	8	2	2	4
Through transverse mesocolon ..	17	—	—	6 +
Into broad ligament	4	—	—	3
Other fossæ	5	—	—	5

I am indebted to Sir Berkeley Moynihan for permission to use *Figs.* 290, 291, and 292.

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THE RESULTS OF PERINEAL EXCISION IN THE TREATMENT OF CARCINOMA OF THE RECTUM :

ANALYSIS OF 143 CASES.

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THE present series of 143 cases represents the total number of perineal excisions of the rectum with colostomy which have been performed in St. Mark's Hospital from 1910 to July, 1924. This paper is intended to give a precise account solely of the results of this operation, immediate and remote, corrected to July, 1924. No case of other modifications of perineal excision has been included in this series, such as perineal excision with preservation of sphincters or formation of a sacral anus.

The type of operation has been that described by Lockhart-Mummery,¹ and may briefly be summarized as follows: A preliminary permanent colostomy is established, and seven to fourteen days later the perineal excision of the rectum is performed. The anus having been closed by a silk purse-string suture, an incision is made round it and is extended posteriorly; the coccyx is disarticulated and the levatores ani are divided with scissors well away from the bowel. The rectum is dissected from the structures anteriorly, using straight scissors and gauze dissection, and the peritoneum is opened anteriorly. The mesorectum is stripped up from the sacrum posteriorly, and is finally divided down to the bowel as high as long forceps and scissors can reach. The bowel is then mobilized sufficiently to enable it to be pulled down and divided well above the growth. The bowel is invaginated with several layers of catgut sutures, and the peritoneum is sutured to the stump, leaving the closure of bowel extraperitoneal. The perineal wound is closed with, or sometimes without, drainage.

The majority of the excisions have been performed under spinal anaesthesia, with scopolanine and morphia, or gas and oxygen.

MORTALITY.

Immediate Mortality.—Under this heading is included every case in which death occurred in hospital following the operation. Out of the total of 143 cases there have been 22 deaths, i.e., 15.4 per cent immediate mortality. During the course of the last three years the operation mortality has been reduced to 12.0 per cent (7 deaths in 58 operations: *see Table IV*). The distribution of deaths between males and females, and the particular cause of death are set out in *Tables I and II*.

The increased risk of operation in males as compared with females appears clearly (18 per cent compared with 11 per cent).

Table I.—OPERATION MORTALITY.

		NO. OF CASES	NO. OF DEATHS	MORTALITY
				Per cent
Males	.. ..	89	16	18.0
Females	.. ..	54	6	11.0
Total	.. ..	143	22	15.4

Table II.—OPERATION MORTALITY: CAUSE OF DEATH.

CAUSE	MALE	FEMALE	TOTAL
Sepsis	7	4	11
Urinary fistula	3	1	4
Pneumonia	2	—	2
Shock	1	1	2
Intestinal obstruction	1	—	1
Exhaustion	1	—	1
Cause indefinite	1	—	1
Total	16	6	22

Local sepsis, with death from toxæmia or septicæmia, occurred in 11 cases. There were 4 fatal cases of urinary fistula: 3 were in men, in whom the fistula was in connection with the bladder or urethra, and 1 was in a woman whose left ureter was injured, with subsequent ascending pyelonephritis. Post-operative pneumonia accounted for 2 fatal cases. There were 2 deaths from shock in this series. One case was that of a female, age 45; severe hæmorrhage occurred in the course of the operation, and she died a few hours later. The other was a man, age 58, whose growth was found at operation to be adherent to the sacrum; a large portion of bone had to be removed with the growth, and persistent hæmorrhage occurred in the course of a difficult operation; in spite of blood transfusion he went down-hill and died twenty-four hours later. One case of intestinal obstruction in a male subject occurred three days after perineal excision. His abdomen was explored, and a loop of small gut was found to be strangulated in the internal foramen formed between the abdominal wall of the left iliac region and the colon as it came forwards to the left hypogastric colostomy. The loop of small intestine was viable and was freed, but the patient did not survive. One man died from exhaustion for no definite cause a month after operation, and in one case in which death occurred on the third day the notes are defective.

Ultimate Mortality.—Of the 121 patients discharged from hospital convalescent after perineal excision 44 are known to be dead. An analysis of their duration of life after operation shows that when recurrence takes place it causes death, as a rule, inside 5 years after operation (93 per cent), and that 80 per cent of these deaths occurred inside 3 years. *Table III* makes this clear:—

Table III.—TABLE OF 44 SUBSEQUENT DEATHS, SHOWING DURATION OF LIFE AFTER OPERATION.

UNDER 1 YR.	1-2 YRS.	2-3 YRS.	3-4 YRS.	4-5 YRS.	5-6 YRS.	7-8 YRS.	INDEF.
12	17	6	3	3	1	1	1

A consideration of the cause of death, so far as can be ascertained, shows that recurrence in the pelvis occurred in 11 cases, in the abdomen or liver in 11 cases, and 2 are alleged to have had secondary deposits in the brain. In 16 cases the cause of death has not been ascertained, while in 4 cases the cause was probably unrelated to the carcinoma of the rectum: thus cerebral hæmorrhage is stated to have brought about the death of 2 patients who were otherwise well; one female developed a highly malignant and rapidly fatal carcinoma of the breast between 4 and 5 years after operation. The case of the man who died in the 7th year after perineal excision has been described by Lockhart-Mummery²: in the 4th year after excision a constricting carcinoma developed in the blind colonic segment well away from the pelvic floor, without any evidence of secondaries in the pelvis or abdominal glands; it was considered to be probably a new formation, not related to the rectal growth; this second carcinoma was excised, but the patient died 3 years later with extensive deposits in the liver, aortic glands, and glands in the neck.

A consideration of the 35 deaths occurring in less than 3 years after operation shows that in 15, i.e., 43 per cent, there was extra-rectal spread at the time of operation. Thus in 5 cases a mass of glands and thickened lymphatics was found in the mesorectum, and death occurred from recurrence in the liver in each case at intervals varying from 10 months to 2 years 4 months; in 5 cases the growth had involved prostate, bladder, vagina, or the tissues posteriorly; 2 cases were associated with abscess formation, one a peri-anal abscess, the other a high-lying post-rectal abscess which was discovered at operation, evidently due to perforation of the rectal wall at the base of the ulcer; in 2 cases the growth had extended down to the anus; in one case, what was thought to be a small, secondary nodule was felt in the liver when the preliminary colostomy was done, but it was decided to perform the excision in spite of this. Many of the remaining 20 cases, though movable, presented extensive and deeply ulcerated tumours, and in 2 of the cases the growth was several inches above the peritoneal reflection, rather beyond the scope of a perineal excision.

In every case in which recurrence occurred in less than one year after operation, some local cause such as those just mentioned had been found to account for so rapid a recurrence.

Cases Untraced.—Thirteen cases are untraced, of whom 11 were operated upon more than 5 years ago. It is possible that some of these may be still living, because in 1920-22 three were traced and known to be living free from recurrence for periods of 9, 4, and 3 years respectively: they

have subsequently been lost sight of. One case was known to be recurrent in 1919 when last heard of.

ANALYSIS OF CASES.

Cases Now Living After Perineal Excision.—By deducting from the total 143 cases 22 immediate deaths, 44 subsequent deaths, and 13 untraced, the figure is arrived at of 64 patients who are now living after perineal excision.

Table IV shows the cases grouped into three main divisions: (1) Those operated upon within the last 3 years; (2) Those operated upon between 3 and 5 years ago; (3) Those operated upon more than 5 years ago. The table is an important one, and from it can be easily calculated the operation mortality in the different periods, and the percentage of cure.

Table IV.—CASES GROUPED ACCORDING TO LENGTH OF TIME WHICH HAS NOW (JULY, 1924) ELAPSED SINCE OPERATION :
INDICATING PERCENTAGE OF CURE.

	LESS THAN 3 YEARS AFTER OPERATION	BETWEEN 3 & 5 YEARS AFTER OPERATION	MORE THAN 5 YEARS SINCE OPERATION	TOTAL
No. of cases	58	22	63	143
Immediate mortality ..	7	6	9	22
Subsequent mortality ..	8	9	27	44
Untraced	1	1	11	13
Alive with recurrence ..	3	1	1	5
Alive and well	39	5	15	59

So far as is known as the result of a very recent inquiry, these 64 cases are all well and free from recurrence with the exception of 5: 3 of these are under 3 years' duration, recurrent in perineum, pelvis, and liver respectively: one is a man who now, 4 years after operation, has irregular hæmorrhage and discharge from the distal colostomy opening, which is most probably due to recurrence in the intrapelvic portion of the colon, and the last is a man 6½ years after operation in whom the growth has definitely recurred in the segment of colon distal to the colostomy, together with secondary deposits in the liver.

To refer now to the cases alive and well at the present time, it will be seen from *Table IV* that there are 39 cases less than 3 years after operation, 5 between 3 and 5 years, and 15 more than 5 years since excision. These last are the most important.

There are two cases free from recurrence 13 years after perineal excision: one is a lady now 82 years old, who is still able to do some house-work; the other is a man of 72 who, until two years ago, did his work as a sewer foreman. There is one case alive at 10 years, one at 9 years, two over 8 years, and 9 cases alive and well at periods of 5 to 8 years after operation.

The functional result in most of these cases is extremely good. Thus, to consider the 20 cases of over 3 years' duration free from recurrence, we

find the following results : 6 are women, of whom 5 are able to do their housework, and one works as a stationer's assistant. Of the 14 men under consideration, 10 perform such varied work as the following occupations suggest : printer's cutter, fish-curer, schoolmaster, packer, tailor, pilot, messenger, waiter, plate-layer (age 63), and one does odd jobs. Three are living in the ease of retirement, being now 65, 71, and 72 years old respectively, and one is a stout man of 59 who used to be a farm labourer, but no longer works.

Age.—Advanced age has not been considered in itself to contra-indicate perineal excision. Of these 143 cases, no fewer than 37 were between 60 and 70 years of age, and 4 were over 70. The oldest patient operated upon was a woman of 76 upon whom Mr. Gracine Anderson performed a perineal excision in September, 1923 ; she is at present in good health and carries on light household duties.

The immediate mortality in the 41 cases over 60 years of age was 8 (20 per cent), and 19 of them are at present alive and well for periods of up to 8 years.

The cases under 30 years of age who have been operated upon have, as usual, done badly. There were 3 of these, of ages 26, 28, and 29. Two died in less than 3 years after operation, and the third has never been traced.

Microscopical Examination.—In the earlier cases in this series histological examination was, unfortunately, only seldom carried out. While all the cases done in recent years have been examined, only 8 of the 22 cases living more than 3 years have a microscopical diagnosis of carcinoma. The clinical diagnosis, however, remains, and is not lightly to be queried : at a special hospital like St. Mark's a great wealth of cases is seen, and experience shows that a diagnosis of cancer by sight and touch is only very rarely mistaken. Furthermore, the records of many cases not sectioned are rendered the more valuable in that good macroscopic descriptions of the specimens are available and support the clinical diagnosis of malignancy.

This point is now receiving particular attention, and care is being taken to have a complete examination made of every specimen removed.

Operability Rate.—In the period under review, 1910-24, 521 new cases of cancer of the rectum and colon were admitted into hospital, of which 230 were operable ; this gives an operability rate of 44 per cent. If corresponding figures are taken for the last five years, the operability rate is found to rise to 54 per cent (116 operable out of 216). This latter figure may be somewhat in excess of the true figure, because a certain amount of judicious selection has to be exercised in admitting cases ; there is a limit to the number of colostomy cases that can be dealt with by the nursing staff at one time, and it is not sound policy to fill up available beds with hopelessly inoperable cases while there are operable and borderline cases urgently requiring admission. It is our practice to admit for further examination and exploration every case in which there appears to be the remotest possibility of the growth being excisable. Probably about 50 per cent is a good estimate of our present operability rate.

The following three cases are examples of the advanced conditions of growth which have been considered as operable. They show what brilliant

results may be obtained by perineal excision for cancer in the middle and lower thirds of the rectum.

Case 1.—F. R., male, age 57, 1918, under the care of Mr. Lockhart-Mummery. He presented an ulcerated growth low down on the anterior rectal wall. Preliminary colostomy was done on Dec. 2, 1918, followed a week later by perineal excision. The prostate was found to be involved, and a portion of the prostate, together with the seminal vesicles, was removed with the growth: the bladder was opened and sutured with catgut. The patient made a good convalescence without any urinary leak: since then he has remained in good health, and in a letter dated June, 1921, he states that his health is good and he does light work as a packer: his colostomy is satisfactory, the wound is healed, and there is no sign of recurrence.

Case 2.—H. J., male, age 49, 1919, under Sir Charles Gordon-Watson. He was a stout, florid-looking subject, with a hard irregular growth in the posterior wall of the rectum extending down to the anus: his inguinal glands on the right side were enlarged and hard. A preliminary colostomy with a gland dissection of the right groin was performed on April 30, 1919, and on May 5, a perineal excision was done. He made a satisfactory recovery, and was discharged on June 7th. The growth was proved to be a columnar-celled carcinoma with secondaries in the inguinal glands. Since then he has carried on his former work as a bank messenger, and in a recent letter he states that his health is good, and he is doing his work, that his wounds are healed, and that there is no sign of return of the growth.

Case 3.—W. B., male, age 66, in March, 1920, under the care of Mr. Lockhart-Mummery. He seemed old for his years, and in a poor state of health generally: he was a waiter. He presented an extensive malignant growth in the middle third of the rectum, and had been sent in from out-patients as a border-line case for examination. It was decided that the growth was removable, and he was treated by colostomy and perineal excision. He subsequently developed a urinary fistula, probably from sloughing of the base of the bladder, but after a stormy convalescence this healed and he recovered. Since then he has resumed his work as a waiter, being now 70 years old. He looks extremely well, and a recent examination showed his perineal wound is soundly healed and that there is no sign of recurrence.

Percentage of Cure.—In estimating the percentage of cure, all cases done less than 3 years ago must be excluded. In *Table V* are shown the percentage of 3- and 5-year cures, the figures being arranged in two divisions calculated on (a) the total numbers submitted to operation, (b) the survivals from operation. This duplication of figures seems to be necessary for clearness owing to the different standards adopted in recording results such as these.

Table V.—PERCENTAGE OF CURE.

DESCRIPTION	3-YEAR CURE	5-YEAR CURE
a. Figures based on total numbers submitted to operation ..	23.5 per cent (20 out of 85)	24.0 per cent (15 out of 63)
b. Figures based on survivals from operation	28.5 per cent (20 out of 70)	28.0 per cent (15 out of 54)

The remarkable similarity between the figures for 3- and 5-year cures in the two columns will be noted, and might have been expected from a

consideration of *Table III*, which showed that 80 per cent of subsequent deaths after operation occurred inside 3 years. The anomaly in division (*a*) of the figure for 3-year cures being less than that for 5 years is due to the abnormally high operation mortality in the 3- to 5- year period, which point is shown corrected in division (*b*).

In conclusion, I wish to express my thanks to the Medical Research Council for their financial assistance in starting and carrying on the cancer follow-up scheme of which this paper is the firstfruits, and to my colleagues at St. Mark's Hospital for their ever-kindly help and encouragement.

Finally, in publishing these results, a tribute should be paid to the nursing staff of St. Mark's Hospital, many of whom have given long years with devotion and enthusiasm to the nursing of these cases.

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CASE OF OSSEOUS METASTASIS FROM PRIMARY CARCINOMA OF THE RIGHT MAMMA.

By SIR GEORGE THOMAS BEATSON, K.C.B., GLASGOW.

ALTHOUGH the cause of cancer is still an unsolved mystery, we know that the disease, notwithstanding its local origin, eventually, as a rule, spreads throughout the body, and that it may do so either in a slow and stealthy manner, or it may advance with rapid and giant strides under conditions which seem to favour its progress. To these new manifestations of the disease the term 'metastasis' has been applied, and they are the important element in cancer, being often the main factor in its ultimate fatal result. That metastases vary with the situation of the primary growth is a well-known fact, so that the prognosis in a case of carcinoma is to a great degree affected by the initial seat of origin of the disease. This is well illustrated by the study of the course of primary cancer of the uterus and breast. In 1914, Lazarus-Barlow¹ stated that the experience of the Middlesex Hospital (and it is borne out by my own at the Glasgow Royal Cancer Hospital) shows that 55 per cent of autopsies on cases of carcinoma of the cervix uteri reveal the complete absence of metastasis, while only 3·2 per cent of autopsies in mammary cancer show a similar freedom—a fact that must be a considerable bar to successful radiation against recurrence in these latter cases.

Ignorant though we may be of the exciting cause of cancer, it is no longer a mystery as to how it spreads throughout the body. Clinical and pathological study have elucidated the method by which the infection is carried, and the roads by which it travels. No longer are metastases regarded as evidence of a 'cancerous diathesis', or the outcome of 'cancer juice' diffused through the tissues and organs. They are indications that cancer cells have travelled to the points affected and are behaving as 'secondary tumours'. Whether these detached cellular elements find their way along by 'spontaneous movements' (Roger Williams), by 'permeation' (Handley), or by 'forcible dissemination' (Beatson), is immaterial. What we do know is that the two channels of dissemination are the lymphatics and the blood, and that in some cases both routes are followed at the same time. By Handley, lymphatic dissemination is upheld almost to the exclusion of that by the blood.

Reference has already been made to the frequency of metastases in mammary carcinoma, and an analysis of the seat of their occurrence has been studied by Gross. His table is based on 423 necropsies that he had collected. From it we learn that the pleuræ (50·9 per cent), lungs (49·9 per cent), liver (48·6 per cent), and bones (20·5 per cent) were the organs and structures chiefly attacked. In the case of the bones there exists a considerable variety of opinion as to whether general osseous invasion is common or the reverse, and as to the frequency with which individual bones are attacked. This uncertainty

is probably due to the fact that autopsies on cancer patients are not always complete in connection with the osseous system, so that nothing would be gained by discussing the point. Looking, however, to the view expressed very emphatically by Handley that in mammary cancer secondary bone deposits only *occur in bones which lie partially or wholly in the area liable to subcutaneous nodules*—in other words, that they are due to lymphatic dissemination and not to blood infection—the following case is of interest.

CASE REPORT.

Mrs. F., age 55, was admitted to the Glasgow Royal Cancer Hospital under my care in August, 1913, complaining of a swelling in the right breast of six years' duration. The family history showed that her mother died at the age of 84, of senile decay, and that her father's death was due to cancer of the tongue. She was one of a family of eight, and had only one brother alive. Two of the brothers died abroad, another from consumption, and one sister from 'a complication of troubles'.

HISTORY.—The personal health of the patient had always been good. She had been married for twenty-eight years, but had no family. She never had any trouble with the right breast, and no injury to it. Six years previously she had noticed a lump in it. She consulted a medical man, but nothing was done. The lump gradually increased, giving her, however, no inconvenience until March, 1913—about four months before admission to this hospital—when she felt her right arm less useful and began to suffer from sciatica in her left leg, which caused some difficulty in walking. Apart from these symptoms her general health was good and she had not lost flesh.

ON ADMISSION.—The upper quadrants of the right breast were completely infiltrated with the new growth, and it had to a slight extent invaded the lower quadrants. To the feel the growth was very hard and very irregular in shape. It was adherent to the skin, which was bossed in places and discoloured, but was not broken. The nipple was retracted. There were some subcutaneous nodules to the right of the upper part of the sternum, and the right axillary glands were enlarged. There was no swelling of the arm, and no tenderness was complained of in handling the growth. As far as physical examination showed, there were no metastases in either the thorax or abdomen. Careful examination of the spine revealed no tenderness, nor could any be elicited along the left sciatic nerve. The only thing noticeable was a complaint of stiffness in the outer muscles of the left thigh. The urine was acid, and contained neither albumin nor sugar.

The diagnosis was that of carcinoma of the mamma. As the case was not suitable for any attempt to remove the growth locally, and as the possibility of general dissemination of the disease was recognized, no operative measures were undertaken, and palliative treatment only was followed.

During the first two months of patient's residence in hospital nothing special occurred. The chief symptom was a very constant complaint of rheumatic pains in the back and limbs. The case chart shows pulse, respirations, and temperature to have been normal. On Oct. 3 a significant incident happened in the form of a fracture of the right clavicle when the patient was

raising herself in bed. It was treated by rest, and union resulted, as was confirmed at the post-mortem examination. On Oct. 12 bosses were noticed on the scalp, and a skiagram showed implication of cranial bones. The further chief notable incidents in the case were the fracture of the left humerus on March 2, 1914, and of the left femur on March 18. There was also loss of sight in the same month. Skiagrams showed the presence of carcinosis in all the bones of both limbs, and the urine on March 7 revealed Bence-Jones' albumose—a recognized indication of extensive bone involvement. The pathological report of the urine on March 7, furnished by Dr. Whittingham, was as follows: "Acid: sp. gr. 1018: no sugar: no albumin, but a trace of Bence-Jones' albumose." A further report on March 9 gave the amount of urine in twenty-four hours as 1000 c.c., against the normal 1500 c.c. and of 0.018 gm. of urea per c.c. as against a normal 0.02, giving 18 gm. of urea in twenty-four hours against the normal 30 gm., almost half less than the normal amount. The pathological report of the blood on March 4 was as follows:—

Blood-count—

Red blood-corpuscles	..	3,500,000	Colour index	..	1
Hæmoglobin	..	70.0 per cent	White blood-corpuscles	..	70,000

Differential Count—

Granular series	85 per cent (normal 75 per cent)	Myelocytes	..	4.0 per cent
Neutrophils	..	Hyaline series	15 per cent (normal 25 per cent)	
Eosinophils	..	Small mononuclears	11.0 per cent	
Transitionals	..	Large mononuclears	4.0 per cent	
	3.0 per cent			

There were thus present a secondary anæmia and marked leucocytosis, mainly of polymorphs. On April 23, 1914, the patient died, and on the following day a post-mortem examination was made by Dr. Harold Whittingham, to whom much credit is due for the interest he took in this case, and for his valuable reports on it. Without these the case would have been very incomplete and much of its usefulness lessened.

POST-MORTEM REPORT.

The body is that of an emaciated woman. A *tumour mass* occupies the right mamma, extending from the anterior axillary line to within an inch of mid-sternal line transversely, and from 2nd to 6th ribs in the mid-clavicular line vertically. The nipple is retracted. There is slight ulceration in one spot (*Fig. 296*). Surface of growth bossy, and skin over it bluish-red in colour. Growth fixed to chest wall; skin adherent to growth. The skin round the growth for a radius of 3 in. from the nipple contains numerous small shot-like subcutaneous nodules; a few also felt as far round as the posterior axillary line; one between scapulæ.

The *right axillary lymph glands* are enlarged and hardened. A dense hard tumour mass surrounds the middle third of right clavicle (*Fig. 297*). Right clavicular glands enlarged. Inguinal glands free. Hard bosses felt over bones in frontal, parietal, and occipital regions. The left mamma is free. No œdema of arms or face.

The *right axillary and supraclavicular glands* are much enlarged and

hardened with dense white growth. In the left axilla the pectoral group of glands is involved.

The subcutaneous fat is scanty and normally pigmented.

The right mamma on dissection shows the breast proper to be replaced by dense white carcinomatous growth, which growth has involved the right pectoralis major muscle, and spread as a dense sheath of growth between the pectoralis major and minor to the costocoracoid membrane, especially in the direction of the coracoid process of the scapula. The growth has also penetrated to the thoracic wall. Thus, on the right side the 3rd, 4th, 5th, 6th ribs,

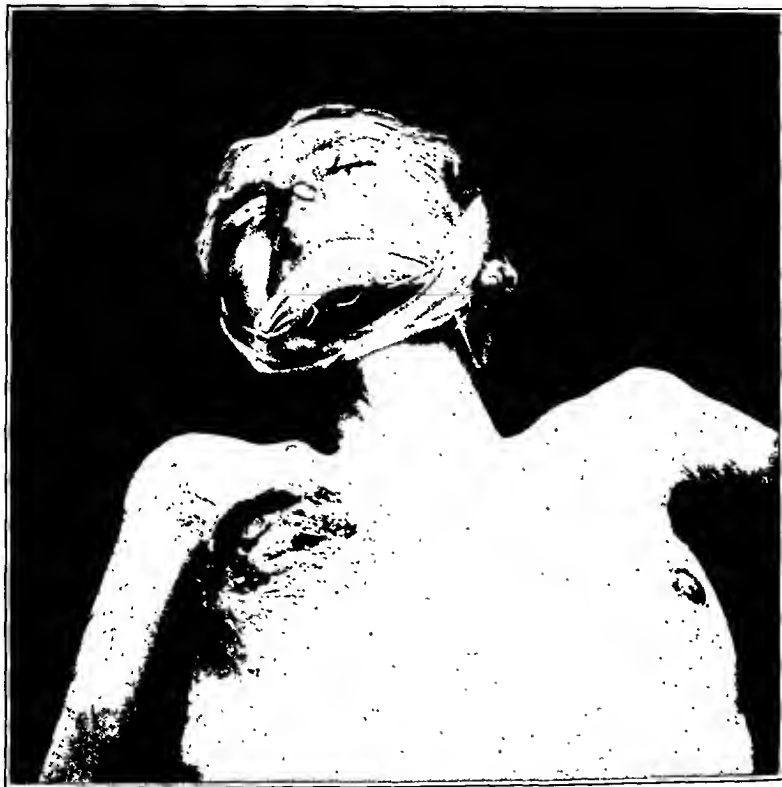


FIG. 296.—Showing the appearance of the breast post mortem.

and 3rd to 6th intercostal muscles are involved, while on the left side the growth has spread across the fascia covering the sternum, and involved the 3rd to 8th ribs and intercostal muscles. The left breast has, however, escaped.

Thorax.—The *pericardium* is chronically inflamed—‘milk-spots’ over the base of the left ventricle and the right auricle anteriorly. No carcinoma found here. The *heart* is of normal size; the cardiac muscle is a little pale (diffuse fatty degeneration). Ante-mortem clot in both ventricles, also in the right auricle and pulmonary artery. Valves normal. Slight atheromatous changes in the aortic arch.

Both *pleural sacs* are more or less adherent all round, especially the right sac. The left sac contains about a half-pint of clear yellow fluid. Small white carcinomatous nodules, varying in size from pin-head to small pea, dotted over both visceral and parietal layers on either side, especially numerous on the right side. Diaphragmatic pleura is thickly studded with these nodules. The spread to pleura is probably lymphatic.

Both *lungs* are studded throughout with small nodules of growth—whitish, and size of a small pea, and probably spread by the blood. No evidence of spread along the bronchi.

The *anterior mediastinal lymph glands* are slightly involved. Posterior set and bronchial glands are apparently free. *Thoracic duct* appears to be free.

Abdomen.—The *periton-eum* contains two small white carcinomatous nodules below the level of the umbilicus and along the course of the right deep epigastric artery. The *liver* is a little enlarged and fatty, with marked perihepatitis. Numerous carcinomatous nodules are scattered throughout the liver both in its substance and near the surface. These nodules vary in size from a split-pea to that of a five-shilling piece, the latter being a nodule in the centre of left lobe of the liver. The nodules in centre are larger than those near the surface. Some are hæmorrhagic and, in places, necrosing.

Many of the surface nodules are umbilicated. Spread here may be lymphatic or blood, or both. The larger size of the central nodules compared with those at the surface of liver points to some, at least, arriving through the blood-stream; some show definite relation to portal tracts. The *stomach and intestines* are normal. The *spleen* free from carcinoma.

The *ovaries* are shrivelled and puckered. The *uterus* contains in its interior a large intramural fibroid, the size of half-a-crown, breaking down in its centre. The *bladder* is normal. The *kidneys* are of normal size. Numerous small nodules of growth are dotted throughout them, especially in the cortex, some of the nodules having a definite relation to the blood-vessels. Some are just under the capsule, but even here a definite layer of renal tissue is seen between them and the capsule—apparently blood-spread to kidneys. There is some involvement of the *aortic lymph glands*.



FIG. 297.—Fracture of right clavicle.

Iliac lymph glands are free of carcinoma, as also are *pouch of Douglas* and *psoas* and *iliacus muscles*. A few slight old adhesions are present in the pouch of Douglas. Calcareous plaques in the *aorta (abdominal)* and *common iliacs*.

Osseous System.—The *right clavicle* (Fig. 297) is the seat of a healed fracture at the junction of its outer and middle thirds. The union is good, and is surrounded with a callus which is found to consist for a great part of tumour tissue. The centre portion of this right clavicle is also cancerous. The spread of carcinoma here has probably been by costocoracoid membrane.

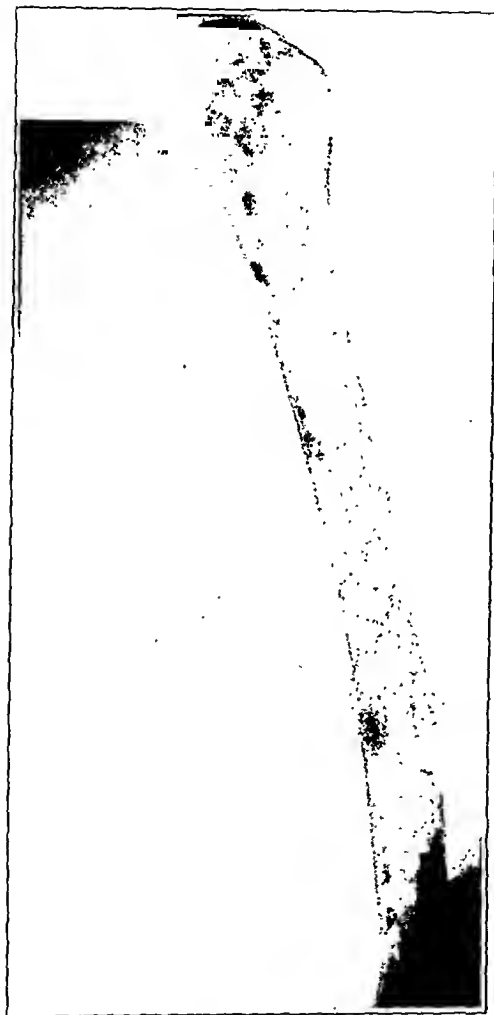


FIG. 298.—Fracture of left humerus.

The *left humerus* (Fig. 298) has fractured below the level of the deltoid insertion. It is incompletely united, much tumour tissue uniting the broken ends and surrounding them. On section of the humerus, nearly the whole medullary cavity is found filled with tumour tissue of a yellowish tinge; towards the centre of the shaft some red marrow is seen amongst the tumour tissue. The infection of the bone appears to have been through the marrow, and then to have spread outwards, eating its way to the surface of the bone by pressure atrophy. The spread to bone was probably by the nutrient artery. The various muscles, tendons, and fasciae going to the humerus were carefully examined, but no evidence of direct spread by this route could be found. The only place where any growth was found in muscles and fascia was around the seat of fracture, and this can be readily explained.

The *right humerus* is also extensively involved in its marrow cavity, but as on the left side no evidence of spread by fascia or tendons, etc., was found.

The *left femur* (Fig. 299) is fractured high up in the upper third of the shaft. The union is poor. Much tumour tissue is present in the callus. On section the whole marrow is more or less replaced by yellowish-white tumour tissue, and some red marrow was still seen here and there towards the centre of the shaft. Compact bone much thinned all round. No increase of growth

noticed at the point of muscle insertions, and no evidence of spread along the tendons, fascia, etc. Apparently blood-spread. Some slight infection of vasti muscles at seat of fracture. The *right femur* (Fig. 300) is in a similar condition, but no fracture present. The *first left metatarsal bone* (Fig. 301) on section shows white nodules of tumour growth in its centre and especially at its distal ends. The *phalanges*—third and fourth middle ones—are in a similar condition, with no sign of tendon spread.

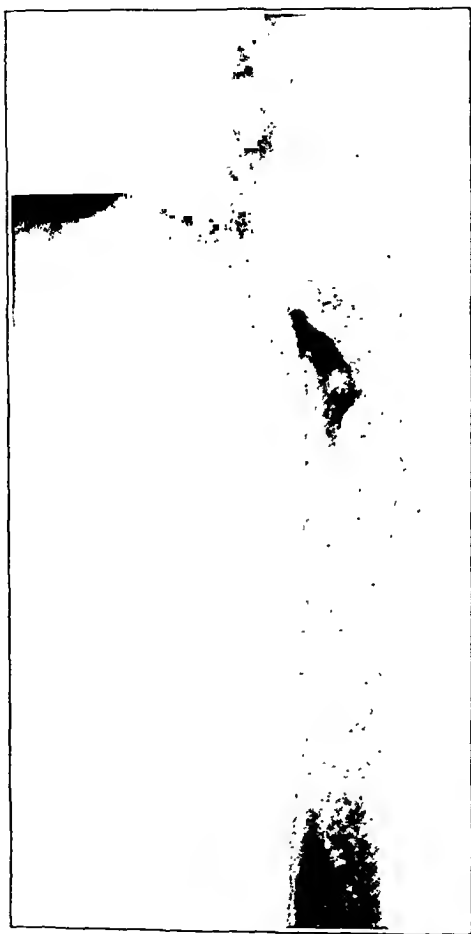


FIG. 299.—Fracture of left femur.



FIG. 300.—Right femur.

The *sternum* is free from carcinomatous involvement, which is strange, as it is often involved in cases of direct or lymphatic spread.

The *3rd to 6th right, and 3rd to 8th left ribs* are involved by direct spread and apparently through the lymphatics.

The *skull* shows fascial spread by cervical fascia, and numerous nodules

lying over the cranial bones and eroding into them. On removing calvarium, varying-sized nodules (5 to 20 mm. in diameter) are also seen between dura and the bone, leading to some compression of the brain, the convolutions being somewhat flattened. At the left sphenoidal fissure a moderate-sized growth involves structures here, and has invaded the sphenomaxillary fossa and back of the left orbit, this, with the cerebral compression, accounting for the optic atrophy. The diploë of the bone of the cranial vault is also involved, here probably from nodules in dura and perieranium, but possibly in addition from the blood. No nodules found in the *brain* or *pia mater*. The optic atrophy on both sides was clearly from cerebral compression.



FIG. 301.—Carcinosis of first metatarsal bone of left foot.



FIG. 302.—Carcinosis of right tibia and fibula.

The 9th to 12th dorsal and 2nd to 4th lumbar vertebrae were found to be extensively involved in their bodies. The cervical vertebrae were not examined. These infections may have been due to lymph-spread by intercostals—especially as some nodules were seen in the anterior spinal ligament in cervical, lumbar, and dorsal regions. No involvement of the cord was found.

The *radii*, *ulnae*, *tibiae*, and *fibulae* (Figs. 302, 303) were all involved, with large nodules and masses of tumour tissue, chiefly in the marrow cavity. In none of these instances could any evidence be found of lymph-spread, and there

was no more tumour tissue at sites of tendon insertions than elsewhere in the bones—in fact, if anything, less. So also in humeri and femurs, and notably in the phalanges examined (*Figs. 304, 305*), where the nodules were most numerous at the distal ends of bones. These points favour blood-spread, though in the case of the ribs, vertebrae, and skull there is evidence of spread by fascial planes and lymphatics.

Sections were made of the mammary tumour, of the infected marrow, of the various bones, and of the scalp, liver, spleen, kidney, and aortic glands. In all of them, save the spleen, there was confirmation of the macroscopic appearances showing that they had originated in a typical spheroidal-celled scirrhous of the mamma.

* * * * *

In the above clinical and pathological record there are several points of interest to be noticed. The first one is the loss of sight in March, 1914. This was not due to cerebral metastases, as there was no carcinoma spread to the brain itself. The blindness was evidently the result of optic atrophy on both sides caused by brain compression induced by the varying-sized nodules found lying between the dura and the bone, and by their subsequent passage down to the middle fossa of the skull, causing at the left sphenoidal fissure a moderate-sized growth which involved the structures there and invaded the sphenomaxillary fossa and the back of the left orbit.

Another point is that the case is illustrative of what has been observed in similar ones—namely, a not very active carcinoma becoming the focus of a silent, stealthy, and widespread osseous dissemination of the disease, accompanied by few local manifestations of its presence. Beyond the complaint of indefinite rheumatic pains, especially in the back, there was nothing to indicate what had taken place. Neither local tenderness in the bones nor tenderness over them was present; nor was pyrexia revealed in the form of rise of pulse or temperature. It was not until the occurrence of the different fractures that attention was directed to the osseous system, and it was only when use was made of the X rays that the extent of the bony lesions was revealed, thus clearly indicating the need for a more systematic use of skiagraphy in all cases of carcinoma, especially of the mamma, and, above all, in those that it is proposed to treat by the deep (Erlangen) X-ray therapy.



FIG. 303.—Left radius and ulna.

Another point of interest to be noted in this case is the reparative power apparently possessed by bones which are the seat of carcinosis. This is well illustrated in the case of the right clavicle (*Fig. 297*), which was the first bone fractured. The post-mortem examination showed that it was the seat of a healed and united fracture at the junction of its outer and middle thirds, although the centre of the bone was cancerous. In this instance the spread of the carcinoma was probably lymphatic by the costocoracoid membrane, for at the post-mortem examination it was found that the mammary tumour had spread through the pectoralis major and was seen as dense white growth infiltrated between that muscle and the pectoralis minor and spreading by it

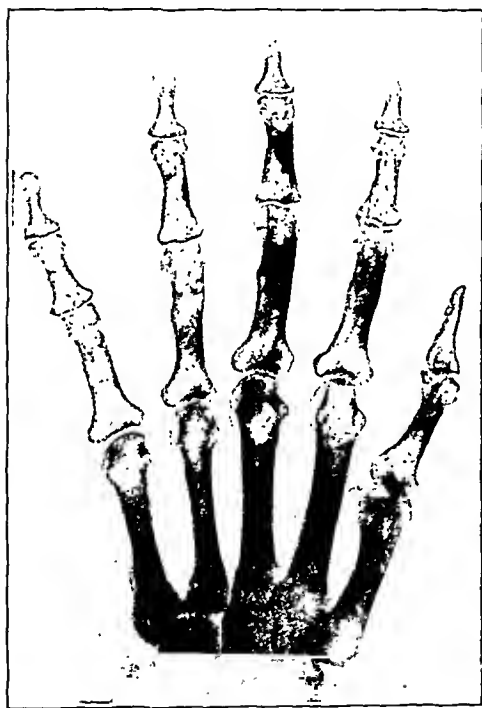


FIG. 304.—Carcinosis of right finger bones.

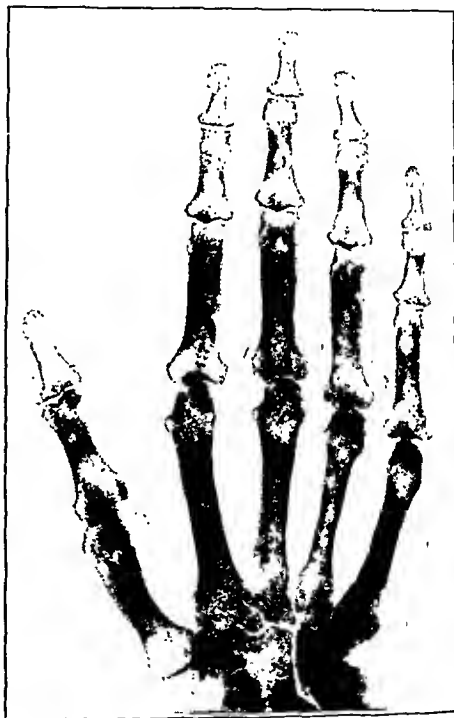


FIG. 305.—Carcinosis of left finger bones.

up to the costocoracoid membrane and to the outer half of the clavicle, where there was callus (largely mixed with new growth) surrounding the firmly united fracture. In the case of the fracture of the left humerus (*Fig. 298*) and left femur (*Fig. 299*) there was good evidence of an attempt at union, but it was incomplete and poor in comparison with the clavicle. In both cases, however, callus was present, though largely composed of tumour tissue.

It is not easy to dogmatize on the course of events that leads up to fracture in bone carcinosis. There may be a preliminary diminution in the salts of the affected bone; but it would almost seem as if the presence of the tumour cells in the interior of the bones did not arrest the powers of the bone-forming osteoblasts on their outer aspect, for the callus present in the united

clavicle, as also in the case of the humerus and femur, was a blend of osteogenic and tumour cells.

In view of the close connection that exists between the red marrow of the long bones and the cellular elements of the blood, it is a very natural question to ask: "What was the blood picture in the case? Did it mirror the condition of the bones? If so, what variations did the formed elements of the blood undergo?" In answer to these queries it may be said that there were very distinct anatomical changes in the blood, and that they are of considerable interest, but they cannot be said to reflect the osseous lesions found by the X rays and confirmed by the post-mortem examination. If reference is made to the pathological report on the blood on March, 1914, seven weeks before death, it shows that there was a distinct diminution of red cells and a great increase of leucocytes, mostly of the polymorph type, with a small percentage of myelocytes; but, beyond this lesser number of erythrocytes, there was no evidence of pathological changes in the shape of nucleated red corpuscles and megalocytes—manifestations one would have expected in such extensive bone-marrow changes. This is a very striking feature in the case. In no way is it in keeping with the blood changes found in what has been called by Piney "the metastatic anæmia of osseous carcinosis".

Harrington and Teacher point out that the recorded cases of osseous carcinosis, secondary to primary carcinoma of the stomach, breast, uterus, bile-duets, and prostate, fall into two groups—one characterized by no special changes in the blood, and the other by very marked variations of a nature suggestive of pernicious anæmia, namely, high colour index, reduction in hæmoglobin and red cells, and the presence of megaloblasts. It is to the first of these groups that this case must be assigned. As to the conditions that regulate or control the anæmia of cancer, probably the most important are ulceration of the primary growth, sepsis, and hæmorrhage. None of these was an active factor in this case, so there was not present in connection with the bone-marrow any 'erythroblastic reaction' which, with its multiplication of red cells normally present in marrow, turns it from yellow into red. In the present case, sections of the right humerus and femur showed the epiphyseal ends of the bones pale and somewhat yellowish, due to the presence of a large amount of tumour tissue, proved to be such by the microscope. The diaphyses contained a little red marrow, but their striking feature was a large amount of whitish and moderately dense tumour tissue. It will thus be observed that the red marrow is absent from the epiphyseal ends of these bones—its normal situation—and that the little red marrow present was seen in the shaft of the bone. The microscopic examination of the tumour tissue in the marrow of the bones showed it to consist of typical scirrhus carcinoma, identical with the condition found in the mammary growth. This latter consisted of strands and clumps of spheroidal epithelial cells lying irregularly amongst a dense and abundant fibrous stroma. In short, the growth in the bones was a typical scirrhus carcinoma, and it had for the greater part replaced the ordinary bone-marrow, but any remains of the yellow marrow showed little change from normal. The first metatarsal bone on the left side (*Fig. 301*) furnishes an illustration of the whole of the contents of the medullary cavity being replaced by tumour tissue.

Interesting as the above-mentioned points are, they are of minor value compared with the importance of this case as a contribution to the still contentious point as to the channel by which osseous eareinosis takes place. Since the abandonment of the 'caneer-juice' explanation of the spread of caneer through the body, two theories as to caneer dissemination have prevailed, namely, the 'embolie' by the blood, and the 'lymphatic' by the lymphatics. In the former, partieles of the primary eareinoma find their way into the blood and are distributed by its current to different parts of the body, where the transmitted cells proliferate and produce secondary nodules, the channels of invasion being either the thoracic duct or the small veins in the vicinity of the primary tumour. In either case, the partieles must pass through the lungs to reach the systemic eirculation. In the lymphatic mode of spread, the extension takes place by the passage of the caneer cells along the lymphatics of the part, thus enabling them to invade neighbouring areas. As to the respective frequency of these two modes of dissemination, the former view was that the embolie process was responsible for the largest number of cases, and in F. von Reeklinghausen it found a strong exponent. In late years another supporter of it has been M. B. Schmidt, of Jena. But to several workers its acceptance presented difficulties, one of the first men to take exeption to it being Mr. Stephen Paget², who, as far baek as 1889, dealt with the subject in a paper published in the *Lancet*. It would serve no good purpose to give in detail the arguments put forward by Mr. Paget, as the work in recent years of Mr. W. Sampson Handley, of the Middlesex Hospital, has made it clear that the usual path of the caneer spread leading to metastases is by the lymphatic system, that embolie dissemination is less common, and that it is not necessary to have recourse to it to explain the osseous and other distant metastases observed in eareinoma, say, of the mamma. This is to a large extent the case, but it does not justify the statement that the earlier view of blood-spread must be abandoned and that "the spread, as was shown by workers at the Middlesex Hospital, is invariably by the lymphatics"³.

The present case illustrates the following points: (1) Extensive involvement of the distal bones of the limbs; (2) Departure from the rule that the liability of a bone to caneer metastases is increased by its mere proximity to the primary growth; (3) The fracture of the left femur high up in the upper third of the shaft and not lower down where compact bone is thinner; (4) The fracture of the left humerus below the insertion of the deltoid musele; (5) The freedom of the sternum from eareinomatus involvement, which is unusual, as it often is involved in cases of direct or of lymphatic spread; (6) Very few skin nodules, although the osseous-spread was very diffuse.

Perusal and careful consideration of the pathological report point to this case being a combination of lymph- and blood-spread from the primary tumour.

The *lymph-spread* is manifest in the skin nodules, the enlarged axillary glands, the involvement of the pleuræ, and in the osseous invasion of the vertebræ, ribs, clavicle, and skull. In the clavicle the caneer had spread by the costocoracoid membrane, and in the skull by the cervical fascia, which gave rise to numerous nodules lying outside the cranial bones under the periosteum forming bosses and eroding the bones. There were also nodules found under the dura mater which had travelled probably by the fascia between the

sutures, and thus were lymphatic in their origin. Fascial spread also occurred in the case of the vertebræ and the ribs.

The *blood-spread* is shown in connection with all the long bones of all the limbs, with the liver, lungs, and kidneys. In the case of the left humerus, the infection was apparently through the marrow, possibly by the nutrient artery, for careful examination of the various muscles, tendons, and fasciæ going to the humerus furnished no evidence of direct spread of cancer cells by these routes. The only place where any growth was found in the muscles and fasciæ was around the seat of fracture, and this condition is easily understood. An examination of the right unfractured humerus gave similar results, although the medulla was full of tumour tissue. The state of matters in the left femur was also corroborative of blood-spread. In the fractured bone the whole marrow was more or less replaced by yellowish-white tumour tissue, with some red marrow still seen here and there towards the centre of the shaft. In this bone, again, there was no evidence of tumour growth at the point of muscle insertions, nor of spread along the tendons, fasciæ, etc. The only thing noticed was slight infection of the vasti muscles at the seat of fracture. The conditions just enumerated were those also present in the right unfractured femur. In the case of the radii and ulnæ, the shafts showed distinct deposits (*Fig. 303*), as also in the tibiæ and fibulæ. In the latter, nothing was found along the attachments to their proximal ends. Confirmatory evidence of blood-spread is furnished by the nodules present in the liver and kidneys. In the case of the liver, the nodules were, as the post-mortem report states, scattered through the organ and were both in its substance and near the surface. The nodules in the centre were larger than the surface ones, a fact that would suggest that they had arrived through the blood-stream, especially as some of them showed definite relation to portal tracts. The infection of the kidneys is in keeping with blood-infection, for some of the numerous nodules dotted throughout them manifested a definite relation to the blood-vessels, while others were just under the capsule with a definite layer of renal tissue between them and the capsule. Lastly, the important link in all blood-infection is furnished by the condition of the lungs, which were studded throughout with small nodules of growth, whitish, and the size of a small pea, and were most probably spread by the blood-current, as there was no evidence that they had travelled along the bronchi.

There are other points in this case to which attention might be drawn, but sufficient has been said in support of the contention that it is clearly confirmatory of the embolic theory of metastases, and demonstrates that both it and lymphatic infection may go on side by side in the same patient, thus indicating the need for some modification of the dictum laid down by the Middlesex Hospital School, that "the spread of cancer is invariably by the lymphatics". Further, it is in no way confirmatory, but rather contradictory, of the contention very strongly emphasized by Handley that there is a relation between skin-infection and bone-infection—in other words, that there exists a resemblance in extent between the areas liable to cutaneous nodules and those liable to metastases in bone. The present case is also quite in keeping with the conclusions come to by Piney⁴ in his valuable paper in this journal, where he brings forward very strong proof that cancerous

metastatic deposits in bones are due to arterial or capillary embolism, in the shape of evidence that vascular channels in the bone-marrow contained both red corpuscles and epithelial cells, side by side, and that his investigations render it an open question as to the existence of lymphatic channels in bone-marrow.

SUMMARY.

1. Carcinoma of right mamma with *lymph-spread* to skin, glands, pleuræ, clavicle, skull, and vertebræ; and with *blood-spread* to all the long bones of all the limbs, and to the liver, lungs, and kidneys, so that the case is partly lymphatic- and partly blood-spread.

2. The blood condition is of interest, showing diminution of red cells with marked increase of leucocytes, mostly of the polymorph type.

3. Skiagrams show that the cancerous foci are not more frequent in the tendinous or fascial insertions, a point well illustrated in the phalanges of the hand, where the tendons are attached at the base, while many foci are more numerous at the apices. They also demonstrate the presence in the radii, ulnæ, tibiæ, and fibulæ of large nodules and masses of tumour tissue, chiefly in the marrow cavity.

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AN INQUIRY INTO THE CAUSATION OF POST-OPERATIVE PNEUMONIA.

BY HENRY FEATHERSTONE. BIRMINGHAM.

SINCE the dawn of civilization, knowledge of the cause of disease has been the principal aim of medical research. But how seldom have men reached the goal! The specific organisms which, as we believe, are responsible for some of the infectious fevers, have been discovered, yet we are still ignorant as to the mechanism which, as the disease appears in different individuals, alters its character and may prevent its development.

The subject under discussion is one of great interest to surgeons and to anæsthetists, for infective diseases of the lung are a serious menace to many patients who have undergone successful operation. To the physician and to the pathologist, the study should repay attention, for the malady begins, runs its course, and ends while the patient is under complete medical control. Theoretically, we should be able to analyse each possible causal factor, and, from our conclusions, draw up an explanation which will enable us to check the scourge in the future.

How far the present essay has succeeded in carrying out this principle is for the judgement of others, but I trust that the time devoted to its perusal may be not ill-spent.

INTRODUCTION.

Material.—The following material is employed in the discussion :—

1. Pertinent literature from Germany, France, Spain, the United States, Canada, and this country, from 1895 till the present day. In the course of the past twenty-five years, these considerable papers have been collected by my senior colleague, Dr. W. J. McCardie, and I have to offer him my grateful thanks for permission to use them.

2. An analysis of the results in one thousand consecutive medical and surgical autopsies, performed between May, 1920, and May, 1922, at the General Hospital, Birmingham, by Professor Shaw-Dunn and his assistants. A general comparison is made with the findings in the post-mortem room at the Queen's Hospital, Birmingham, during the same period. For permission to use this evidence I must thank Professor Shaw-Dunn and Dr. R. G. Abrahams.

3. A comparison of the incidence of pneumonia after operations on the stomach and after hysterectomy, in the series of these procedures which occurred at the General Hospital, between May, 1920, and May, 1922.

4. Records of pneumonia occurring in the surgical wards at the General Hospital from March, 1922, to March, 1924.

5. My own observations as anæsthetist at the General Hospital, the Ear and Throat Hospital, and the Children's Hospital.

Incidence.—In 1897, Dr. Silk¹ referred to the rarity of post-operative pneumonia, and recorded that during 1894 and 1895, 5000 anæsthetic cases were followed by pneumonia on only 13 occasions, of which no fewer than 8 succeeded operations on the tongue or jaw. Prescott, of Boston, had noticed 3 pneumonias after 40,000 administrations. During the next year or two, Stanley Barling,² Pridgin Teale,³ Rumboll,⁴ and Miss Aldrich-Blake⁵ related similar experiences. Dudley Buxton,⁶ Carter Braine, and Silk, in 1900.

Table I.—INCIDENCE, MORTALITY, AND MORBIDITY OF POST-OPERATIVE PNEUMONIA.

AUTHOR	OPERATIONS	PNEUMONIAS		MORTALITY OF MORBIDITY	UPPER ABDOMINAL OPERATIONS	PNEUMONIAS		MORTALITY OF MORBIDITY
		Number	Per cent	Per cent		Number	Per cent	Per cent
1898. Schultz ..	5724	27	0.47	70	—	—	—	—
1898. Anders ..	57,842	46	0.07	—	—	—	—	—
1897. Silk ..	5000	13	0.26	—	—	—	—	—
1898. Barling ..	2000	1	0.05	—	—	—	—	—
1900. Rumboll ..	1500	1	0.075	—	—	—	—	—
1900. Aldrich-Blake ..	1250	3	0.24	—	—	—	—	—
1900. Buxton ..	4914	17	0.34	—	—	—	—	—
1900. Julliard ..	4000	0	—	—	—	—	—	—
1900. Carter Braine ..	4380	1	0.23	—	—	—	—	—
1900. Silk ..	900	1	0.11	—	—	—	—	—
1901. Mickuliez and Henle ..	1787	143	8.0	46	1787	143	8.0	46
1902. Crouch and Corner	3000	10	0.3	10	—	—	—	—
1904. Bibergeil ..	3909	283	7.2	—	3909	283	7.2	—
1904. Gebele ..	1196	77	6.43	—	1196	77	6.43	—
1904. Albanus ..	1140	53	4.64	—	1140	53	4.64	—
1905. Czerny ..	1302	52	4.0	—	1302	52	4.0	—
1905. Kauseh ..	1880	45	2.24	—	1880	45	2.24	—
1905. Kronlein ..	1400	8	0.57	—	1400	8	0.57	—
1906. Lawen ..	9755	180	1.84	65	—	—	—	—
1906. Armstrong ..	2500	55	2.2	64	—	—	—	—
1908. Wight ..	9000	31	0.34	19	—	—	—	—
1909. Risley ..	1000	11	1.11	37	1000	11	1.1	37
1913. Beckman ..	6825	27	0.4	—	—	—	—	—
1917. Cutler and Morton	3490	65	1.86	—	—	—	—	—
1917. Vedin ..	1413	15	1.06	46	—	—	—	—
1918. Whipple ..	3719	97	2.6	—	—	—	—	—
1919. Cleveland ..	1940	65	3.3	—	—	—	—	—
1922. Herb ..	1534	76	—	49	1534	19	1.28	—
1921. Mandl ..	1585	—	8.5	—	1379	—	14.00	—
1922. Smith ..	221	—	—	—	221	—	7.5	—
1922. Elwyn ..	2932	81	2.76	—	1080	—	6.2	—

recovered 17 pneumonias after 4914 administrations, 1 after 4380, and 1 after 900 respectively. J. M. Anders,⁷ of Philadelphia, had seen 1 pneumonia after 300 ether anæsthetics. During this time, quoting from the British and American figures, pneumonia occurred in 41 cases after 60,244 administrations. that is to say, in 0.068 per cent. Silk was justified in describing post-operative pneumonia as rare.

By 1906, however, the results were not so satisfactory. Schultz,⁸ Læwen,⁹ and Le Dentu¹⁰ quoted 28,093 operations, complicated by pneumonia on 868 occasions, i.e., 3.09 per cent. It is significant that many of these operations

were laparotomies, while the earlier series did not include so many operations on the abdomen.

Armstrong,¹¹ Wight,¹² Beckman,¹³ McKesson,¹⁴ Cutler and Hunt,¹⁵ Vedin,¹⁶ Whipple,¹⁷ Henle,¹⁸ McKesson,¹⁹ Cleveland,²⁰ Isabella Hert,²¹ Mandl,²² Homans,²³ Muller,²⁴ Smith,²⁵ Elwyn,²⁶ and other writers during the last fifteen years, have reported series of cases in which the morbidity varies from 0.5 to 8 per cent.

The series of records shown in *Table I* indicates, where noted, an exceedingly high death-rate; thus, from 40 to 60 per cent of the patients who developed pneumonia died. It appears likely that, in most surgical clinics, lesser attacks of pneumonia escape recognition; only the more severe cases attract attention, and of these a very large proportion prove fatal. My own experience at a large general hospital of 400 beds has demonstrated how difficult it is to obtain reliable information concerning the incidence of this disease. A system of notification of all suspicious 'chest' cases occurring after operation has been in force for two years, but owing to the frequent changes of resident officers, and the pressure of other work, mild or abortive attacks of pneumonia often escape observation.

Table II.—INCIDENCE OF PNEUMONIA FOUND POST MORTEM IN MEDICAL AND SURGICAL CASES.

DESCRIPTION OF CASES		AT QUEEN'S HOSPITAL	AT THE GENERAL HOSPITAL
MEDICAL	Number of medical autopsies (excluding primary pneumonias)	283	350
	Number of secondary pneumonias occurring in the above	97	89
	Percentage of deaths in pneumonia cases ..	34.27	25.42
SURGICAL	Number of autopsies on patients who died shortly after operations under local or general anaesthesia	178	385
	Number of pneumonias (excluding empyema cases)	75	138
	Percentage of pneumonias to deaths	42.13	35.84

Table II demonstrates that pneumonia is a frequent complication in any killing disease whether an operation was performed or not.

Hospitals which deal with the less severe surgical operations report that post-operative pneumonia is extremely rare. Dr. W. R. Jordan,²⁷ who in the course of thirty years administered chloroform on 11,200 occasions, at the Birmingham Royal Orthopaedic and Spinal Hospital, met with but one case of this complication. In my work as anaesthetist at the Birmingham Ear and Throat Hospital, I have only heard of three or four mild cases of pneumonia during a period of four years. But on the other hand, at the General Hospital, from May, 1920, to May, 1922, 222 consecutive severe operations on the stomach (that is to say, gastrectomy, gastrojejunostomy,

or suture of perforated ulcer) were complicated by pneumonia in 24 cases, i.e., 10.81 per cent.

The foregoing records illustrate that pneumonia may occur often or seldom in different series, and that our analysis must be wide and searching if we are to find the cause.

Course and Varieties.—The first symptoms may occur a few hours after operation or not until after many days,³¹ but the onset is rarely earlier than twenty-four hours or later than five days after operation. If more than a week has elapsed before pneumonia sets in, we usually find some other cause, such as progressive failure, and both operation and anaesthetic may justly be exonerated.

The subsequent course, naturally, differs with the variety of the disease, but most surgeons, I find, recognize two main types. The first we may call 'the abortive type', which corresponds to the 'pneumonitis' described by Whipple.¹⁷ Never by itself fatal, its sudden onset is characterized by absence of chill or rigor, by sharp rise of temperature, moderate cough, and some pleuritic pain. The temperature falls by lysis after forty-eight hours. During the first few hours radiography shows a shadow in the lung "often wedge-shaped, and usually in the lower lobes". Over the affected area there is dullness on percussion, and the breath sounds are diminished. Later, tubular or even bronchial breathing may be heard. In 11 out of 97 cases, radiographic examination showed a shadow before the physical signs of consolidation were elicited. Mason³⁰ thinks these shadows begin at the periphery and extend to the hilum. He suggests that bronchial breath sounds are not heard until the shadow extends from the periphery to the hilum. Rusty sputum is rare, but yellow mucus is expectorated, from which the *Group IV* pneumococcus may be grown both before and after operation.

In his account, Whipple does not mention any displacement of the heart, but in many respects his description tallies with that which Pasteur²⁹ gives of 'massive collapse' of the lung. According to Pasteur, there are two well-defined clinical types of massive collapse, one acute, the other latent. The acute type may present a sudden initial dyspnoea resembling pulmonary embolism, or, more commonly, a rapid but less dramatic onset suggesting pneumonia. In the latent type "there may be a complete absence of symptoms, although the physical signs are well developed". Undoubtedly these cases often escape attention. Pasteur, however, refers to "a sudden onset", "deep-seated pain in the lower part of the chest", viscid mucous expectoration which is not blood-stained, dullness over affected base, diminished breath sounds or tubular breathing, loss of vocal fremitus, and a sharp rise in temperature to 103°. He tells us that the symptoms rapidly subside in the absence of the development of secondary bronchopneumonia, but that this is quite likely to occur. He emphasizes paresis of the diaphragm, often unilateral, imperfect movement of the affected side of the chest, and over-action of the opposite side. Of primary importance, the heart is dislocated towards the affected side. Displacement of the heart he regards as pathognomonic. By radiography, before and after operation, Pasteur has satisfied himself that paresis of one half of the diaphragm is a frequent result of abdominal and other operations, and this often passes off unobserved. Further space will be devoted to the consideration of the mechanism of these conditions.

The second principal variety of pneumonia is extremely grave. I recognize a type of spare middle-aged man, often with emphysema of the lung and very little costal movement on respiration, who, though in fair general health, is poorly nourished as the result of gastric or duodenal ulcer. In the course of an hour, a severe operation is performed on his stomach, and he recovers consciousness uneventfully, although rather pale and weak. Twenty-four hours or more after operation, the colour becomes cyanotic, the pulse and temperature rise, the lungs give evidence of patches of consolidation or at least of areas of collapse, and only too frequently death ensues on the fourth, fifth, or sixth day after operation. In the series at the General Hospital, after 106 'clean' stomach operations on men of this class, taken consecutively, pneumonia set in in 21, and of these 13 died. The morbidity was 19.81 per cent, and the mortality was 61.9 per cent of the morbidity.

In addition to these two main kinds, we see examples of terminal lobular pneumonia in exhausted patients, suppurative embolic pneumonia in cases of severe sepsis, hypostatic pneumonia, suppurative aspiration pneumonia after operations on the tongue or jaw, pneumonia lit up in lungs which recently have been the seat of inflammatory disease, but I believe lobar pneumonia to be extremely uncommon. In 138 autopsies on post-operative pneumonia cases at the General Hospital, there were 136 instances of the lobular variety and only 2 with definite lobar distribution.

Bacteriology.—This branch of the subject bristles with difficulties, and much work remains to be done.

In cases of definite blood infection from a septic focus elsewhere, e.g., osteomyelitis of bone, usually streptococci or staphylococci of the same character as those in the primary abscess are discovered in the lung. The cultures are not always pure, and quite often the guilty microbe cannot be demonstrated with certainty.

From cases of pneumonia due to aspiration of particles of vomit or mouth contents, many varieties of germs may be grown in profusion, and the formation of multiple abscesses is found to be of common occurrence.

Whipple,¹⁷ whose research on this subject is by far the most important of those which have been published, found the pneumococcus in nearly all air-borne infections. Neufeld and Handel³³ and, later, workers at the Rockefeller Institute showed that pneumococci may be divided into strains by the reactions of animals immunized against pneumococci obtained from various sources. Four groups have been distinguished. Pneumococci labelled *Groups I, II, III* are parasitic and are found only in the throats of patients who have been exposed to infection, while *Group IV* pneumococci are saprophytic and are present in about 60 per cent of normal persons. Whipple injected the pre-operative sputum into a mouse; if the pneumococcus was found, it was cultured and kept. If pneumonia occurred after operation, the culture from the pre-operative and the culture from the post-operative sputum were tested for *Group IV* pneumococcus. If this variety was found, specimens of blood were taken at three-day intervals and serum agglutination tests were employed with both the above sets of cultures. Whipple "concludes that the majority of post-operative pneumonias have pneumococci of *Group IV* in the sputum; especially is this true in the milder cases, in which the pneumonia develops in

otherwise healthy individuals, and runs a short atypical course".¹⁷ Pneumococci of *Groups I, II, and III* are the causal organisms in severe medical pneumonia and are often found in post-operative pneumonia occurring in epidemics.

Wollstein and Meltzer³⁴ found that experimental intrabronchial insufflation of non-virulent pneumococci in dogs caused an exudation into the alveoli which did not affect the frame-work and which usually was absorbed rapidly, the exudate being very poor in fibrin. Perhaps this is an experimental reproduction of the transient pneumonia which follows invasion of the lung by *Group IV* pneumococcus during or after surgical operations.

Important as this work is, very little has been said authoritatively by other investigators, either in confirmation or in contradiction. During a period of several months, I took post-nasal swabs of patients about to be anæsthetized for severe abdominal operations. Direct smears showed a great variety of organisms, including the pneumococcus, but pneumonia did not occur in the series, so that the research was fruitless. In a more recent case—a man, 35 years old—owing to the presence of pharyngeal catarrh operation was deferred for ten days. At the end of this time, the temperature having been normal for six days, upper abdominal laparotomy and appendicectomy were performed. A mild attack of 'bronchopneumonia' commenced on the second day following operation, and all signs disappeared by the seventh day. Before operation pneumococci were found on a post-nasal swab, and after operation a copious growth of pneumococcus was prepared from the sputum. We were unable to ascertain the particular strain of pneumococcus. Probably it belonged to *Group IV*, but cultures of the pneumococcus of known variety were unobtainable at that moment.

To sum up, Dr. Whipple's views are probably true, and, so far as I know, they are borne out by the experience of other workers. A first-rate knowledge of bacteriology, the necessary certificates, much spare time, and ample funds are essential to the pursuit of this research. Unfortunately, hospital bacteriologists and hospital anæsthetists do not possess all these qualifications.

THE POSSIBLE CAUSES.

For many years, in the absence of some obvious cause such as septicæmia, pneumonia which followed operations under general anæsthesia was attributed to the anæsthetic agent. In the following pages, I shall deal with the subject on the widest possible basis, endeavouring to examine and to assess each unaccustomed influence which is brought to bear on the patient at operation.

I think the various items may be discussed conveniently under the following general headings: (1) *The anæsthetic agent.* (2) *The methods of administration of the anæsthetic.* (3) *The operation itself.* (4) *The patient's general condition.* (5) *General systemic disorders affecting metabolism and organs of defence.* (6) *The presence of pulmonary disease prior to operation.* (7) *The patient's respiratory system.* (8) *The process by which the lung becomes infected.*

1. THE ANÆSTHETIC AGENT.

Usually one of three agents is employed to give prolonged general anæsthesia—ether, chloroform, or nitrous oxide and oxygen. I shall review these *seriatim*, together with some remarks on the results obtained with local analgesia.

Ether.—There is a considerable weight of evidence to show that ether is a powerful irritant to the mucous membrane of the respiratory passages. That impure ether, such as the methylated ether of commerce, may be the starting-point of an attack of pneumonia, appears very likely. Dr. Lamb³⁶ has quoted an outbreak of pneumonia which followed the use of commercial ether supplied by a hospital chemist for reasons of economy. Recently, Professor Storm van Leeuwen⁶⁵ demonstrated in some specimens of ether the presence of highly irritant substances which may be extremely dangerous, even in small quantities.

Hölseher,³⁵ in his classical paper, describes the action of ether vapour on the various regions of the respiratory system with which it comes in contact. In the nose and mouth, profuse watery secretion and salivation are excited, but in the trachea, ether acts as a local anæsthetic, and, while paralysing the cilia of the tracheal epithelium, ether insufflation through a tracheotomy tube, or by an intratracheal catheter, fails to produce local secretion, and there is no salivation. The large bronchi do not excrete fluid, but the alveolar epithelium may secrete vigorously. It is found that the amount of secretion varies with individuals and with different species. Some patients may be anæsthetized with pure ether without the usual pre-operative dose of atropine, yet no secretion or salivation will result, while others rapidly become 'water-logged'. Rabbits are readily anæsthetized with ether, and remain 'dry'; but cats produce an abundant secretion. In man, after an operation, sometimes the ether is not quickly excreted, the effect of the atropine wears off, and plentiful frothy secretion, together with a certain amount of œdema of the lung, may result. In these cases a further dose of atropine has an extremely beneficial action.

Large doses of ether vapour undoubtedly lead to petechial hæmorrhages in the lungs of rabbits, as I can testify from my own observations. Poppert³⁷ made dogs inhale strong ether vapour and rapidly produced hæmorrhage and œdema in the lungs. When the administration was arrested the œdema quickly subsided; this has suggested that the ill-effects were the direct result of irritation alone, and that, in these experiments, the hæmorrhage and œdema was not inflammation produced by infection of the irritated tissues. Chapman³⁸ poured liquid ether on a frog's web, thereby causing arrest of the circulation, and rupture of the vessels. In other experiments on rabbits this observer found that: (a) Etherization caused congestion of the alveoli, while with very concentrated vapour intra-alveolar hæmorrhages ensued. (b) Cultures of pneumococci were blown into the lungs during ether narcosis; this was repeated daily for three days, and bronchopneumonia followed. (In my opinion this experiment was too severe for us to formulate any reliable conclusions.) (c) Suffocation alone produced hæmorrhage of the lung.

When we compare these results with those of clinical practice, we find

much that is conflicting. Hæmoptysis after ether anæsthesia is almost unknown, and many workers have commented on the infrequency of blood in the sputum of post-operative pneumonia cases. Further, if ether were so irritating as an anæsthetic, we should expect laryngitis and tracheitis as frequent sequelæ to etherisation, but in practice these complications are almost unknown.

Anders,⁷ Drummond,³⁹ Gerulanos,⁴⁰ Dupley and Hallion,⁴¹ Crouch and Corner,⁴² Wight,¹² and others have blamed ether as the most potent causal factor. In particular, Crouch and Corner⁴² kept careful records of 2400 administrations of ether at St. Thomas's Hospital. Of these, 10 developed pyrexia and respiratory trouble within twenty-four hours, 1 of whom died. Not one patient of 600 who received chloroform showed this early respiratory disease, which is the more surprising because many of them had undergone mouth and tongue operations, which are common precursors of lung trouble.

On the other hand, Hölscher, Reamy,⁴³ Le Dentu, Silk, Cutler and Morton, Whipple, Elwyn,²⁶ and many others do not blame ether as the most potent factor in the production of bronchopneumonia after operations. At the German Surgical Congress held in 1905, of nine surgeons, three blamed ether, one exonerated ether, and five did not deem ether or chloroform very guilty. Silk⁶ has said that post-operative pneumonia was extremely common before the days of anæsthetics and antiseptics; indeed, he has known of ether being administered to cases of pneumonia without affecting the course of the disease. I can confirm this from personal experience. Many of us can recall cases of subacute bronchitis clearing up rapidly after etherization.

Now, many anæsthetists consider ether should not be given in too great concentration. Mrs. Dickenson Berry,³⁶ who possesses unrivalled experience with light ether anæsthesia for thyroidectomy, records over one thousand administrations of ether with only one pneumonia. My colleague, Dr. Hassall, thinks bronchitis, or even pneumonia, may be expected in alcoholic persons, who struggle during induction and inhale massive doses of nearly pure ether vapour. Certainly, depth of ether anæsthesia is not to be blamed, for I have records of 1179 operations for nose and throat affections performed by Mr. Musgrave Woodman under prolonged deep ether narcosis, followed only in 1 case by pneumonia (after diathermy of a malignant ulcer in the mouth). But deep anæsthesia should not be attained with concentrated vapour; free respiration and uniform inhalations of a vapour of regular strength (say, 20 per cent) rapidly lead to deep narcosis with a good circulation, effortless respiration, and little or no irritation of the lung tissue. In this connection I may quote Dr. Geoffrey Marshall's⁴⁵ results with cold and warm ether vapours (in France). Fifty-four per cent of abdominal cases developed bronchitis or pneumonia after 'open ether', while with warmed ether vapour chest complications ensued in only 14.7 per cent. Dr. Shipway, one of the pioneers of the 'warmed ether vapour technique', has obtained similar results. It seems reasonable to suppose that the rapid evaporation of large quantities of ether on a soaked open mask causes great cooling of the apparatus and the formation of a fog of ether droplets, instead of the warm, non-irritating gas produced by the warmed ether apparatus (cf. the animal experiments quoted above).

Many writers very wisely draw attention to the exhaustion produced by

the prolonged administration of ether. I think this may be reduced by careful attention to free respiration, warmth, etc.

We may note that Graham⁴⁶ showed that ether checks phagocytosis in the body, and also in blood treated with ether *in vacuo*. He found that fats and lipoids reduced this inhibitory action of ether, and that a subcutaneous injection of lecithin, or a rectal administration of olive oil, rapidly restored the opsonic index count to normal. On the other hand, Dr. Flemming,⁴⁷ in a few estimations, always found that after ether anaesthesia the opsonic index count was raised.

I now turn to the consideration of certain results obtained at the General Hospital, from May, 1920, to May, 1922. During this period, 222 operations were performed on the stomach. The nature of the operations was gastro-enterostomy, partial gastrectomy, or suture of perforated ulcer.

Ether was given in 158 cases: pneumonia occurred in 15 = 9.43 per cent.
Chloroform* was given in 64 cases: 9 = 14.06 ..

The post-mortem records for this period give interesting information. In 385 autopsies on patients who had died within ten days of operation, pneumonia was found in 138.

Of 138 pneumonia subjects:—

Ether was used in	67 = 48 per cent.
Chloroform was used in	53 = 38 ..
Gas and oxygen was used in	6 = 4 ..
Local anaesthesia was used in	12 = 8.7 ..

Of 385 surgical autopsies:—

Ether was used in	203 = 52 per cent.
Chloroform was used in	110 = 28 ..
Gas and oxygen was used in	37 = 9 ..
Local anaesthesia was used in	35 = 9 ..

Thus, speaking generally, we may conclude that, although ether had been employed in *more* than half of these fatal surgical cases, ether had been the anaesthetic in *less* than half of the pneumonia subjects. On the other hand, chloroform had been used in *less* than one-third of the fatal subjects, but chloroform was the anaesthetic in *more* than one-third of the pneumonias. Probably the more frequent occurrence of chloroform as a precursor to pneumonia was due to the expectation of lung trouble in these subjects when the anaesthetic agent was being selected. (It may be noted that local anaesthesia had been employed in about 9 per cent of the total surgical autopsies, and that it had been used in the same percentage of those in whom pneumonia had occurred.)

Finally, we are forced to the conclusion that relatively pure ether when administered with reasonable care is not an important cause of pneumonia, and that, most certainly, the routine use of chloroform—a practice still advocated by some surgeons—would not rid us of this grave complication.

*Under the heading of 'chloroform' is included E₂C₂ mixture, of which the quantity of ether inhaled by the patient is negligible. It will be observed that pneumonia occurred more commonly after chloroform.

Chloroform.—In his experiments with chloroform on twenty-two rabbits, Von Lichtenburg⁴⁶ found grave alteration in the lung tissue, including swelling and disintegration of the epithelial cells in the alveoli. This led to bronchopneumonia in several instances. Dr. Flemming⁴⁷ has demonstrated the action of ether and chloroform on *Chlamydonas* (a free-swimming vegetable cell), on free-swimming protozoa (such as *Paramœcium*), and on the cilia of the buccal mucous membrane of frogs. In each kind of cell he found that chloroform, in quite weak dilution, arrested movement, but that a stronger concentration of ether was required to produce paralysis. Furthermore, in all experiments, the etherized cells recovered much more quickly than those under chloroform; indeed, in most cases the chloroform had killed the cells.

Now, Poppert, in his experiments with chloroform on dogs, produced less œdema and smaller hæmorrhages than had been seen after the administration of ether. However, we may conclude that in some patients chloroform acts destructively on the respiratory epithelium and may lead to bronchitis or to pneumonia.

The published clinical results are contradictory. Le Dentu,¹⁰ in a review of 800,000 cases of general anæsthesia, found one death after operation under chloroform anæsthesia in every 2500 administrations, and he considered chloroform to be quite a powerful lung irritant. He states that Richet and Championnière found that chloroform was the anæsthetic in the majority of their post-operative pneumonias. Campiche,⁴⁸ after 511 ether cases, recorded lung trouble in 3 per cent, but after 205 chloroform administrations lung trouble was observed in 5 per cent.

Riley,⁵⁰ writing from Cuba, states that chloroform is his routine anæsthetic agent, and that he never sees pneumonia after operation. Judging from our experience of pneumonia after local anæsthesia and following injuries, we wonder if the infecting organisms are as rife in Cuba as in this country. Again, in the considerable experience of Dr. McCardie, pneumonia has been an extremely rare complication of chloroform anæsthesia. Dr. Jordan, too, states that he has given chloroform to 11,200 consecutive patients for orthopædic operations, with only 1 pneumonia.

That pneumonia does occur only too frequently after chloroform anæsthesia is demonstrated by the findings at autopsy and the records of gastric operations mentioned above.

Owing to the unquestionably poisonous effect of chloroform on the heart, mixtures of ether and chloroform have been employed very generally. Poppert, in a series of 812 administrations of a mixture of 5 parts of ether and 1 of chloroform, had to record 5 deaths from pneumonia. It must be noted that all these fatalities occurred after operations on the stomach or gall-bladder, that is to say, after upper abdominal trauma.

In many hospitals it is the custom to employ a mixture of 2 parts of ether to 1 of chloroform, i.e., E_2C_1 . For all practical purposes this gives chloroform anæsthesia; first, because it must be evaporated on a thin layer of gauze or lint, which permits the small amount of volatile ether to disperse rapidly, so that little or no ether reaches the lungs of the patient; and secondly, because, even were the ether and chloroform to be inhaled in the proportions of 2 : 1, ether only possesses one-eighth of the narcotizing power of chloroform,

so that anæsthesia will still be due to chloroform. (It may be noticed that Rodman, Thompson, Kemp, and others deprecate the use of these mixtures.)

It appears, then, that although there is some evidence that chloroform may play a part in the production of pneumonia, some other more powerful factor is nearly always present.

Nitrous Oxide and Oxygen.—Most authorities agree that lung complications following the use of gas and oxygen would be extremely rare if we did not select it as the routine anæsthetic for cases in which lung trouble is expected. For example, in my post-mortem records, 6 of the subjects had each undergone two operations, the last of which was of a desperate nature. In each of them, a second operation had been performed under gas and oxygen anæsthesia. No fewer than 5 of the 6 showed consolidation of the lungs at autopsy. In this post-mortem series, gas and oxygen had been employed for operations on 37 subjects; 6 had developed pneumonia, and of these, 5 pneumonias followed desperate ante-mortem operations. Of the anæsthetics known to us, nitrous oxide is the least irritating to the respiratory system and the most harmless when absorbed. It is unfortunate that we cannot employ gas and oxygen alone for operations on the abdomen, but the addition of a little ether is a great help.

Mr. H. J. Patterson³⁶ has shown that post-operative rise of temperature after gas and oxygen is less than that following ether or chloroform. Frequently it is my practice, in severe upper abdominal operations, to induce deep ether anæsthesia for laparotomy and exploration of the interior of the abdomen. During the suturing and quiet manipulations which follow, gas and oxygen, under positive pressure, is employed, and later on a little ether is added during the closing of the abdomen. Nevertheless, I have to record during the last year, after the use of this method, one case of mild pneumonia and one which proved fatal. The occurrence of pneumonia, however, was due to other factors.

Local Anæsthetics, including Spinal Analgesia.—In 1901 Henle⁵¹ found pneumonia to be even more frequent after local analgesia than after general anæsthesia. With this conclusion Goebel,⁵² Læwen,⁹ Hendry,⁵³ Mickulicz,⁵⁴ and Griffin⁵⁵ agree. Gastrotomy, whether performed under local or under general anæsthesia, is a frequent precursor of pneumonia. Goebel mentions 4 cases of bronchopneumonia after this operation, while Læwen, in 1955 operations, found pneumonia in 36 per cent of the gastrotomies. Hendry quotes Gottstein's 114 laparotomies under cocaine, 16 of which were followed by lung œdema and 'hypostatic' pneumonia.

Mandl²² records 1283 operations under general anæsthesia with lung complications in 4.66 per cent, and 910 operations with local analgesia followed by respiratory trouble in 4.39 per cent.

On many occasions, in his experience of 8000 cases, Rood⁵⁶ has seen bronchitis and pneumonia follow spinal analgesia and local analgesia. In a series of 100 administrations of spinal analgesia, of which the most careful records were kept, the present writer⁵⁷ saw 2 cases of severe broncho-pneumonia, both of which recovered. One was a woman suffering from loss of blood and diffuse peritoneal shock due to rupture of a tubal gestation. She had a cold at operation, so spinal analgesia was induced. Next day severe

capillary bronchitis had developed, and during the following week widespread bronchopneumonia was present.

Cæsarean hysterectomy was performed on the second patient for severe toxic intra-uterine hæmorrhage at the ninth month of pregnancy. She was pale and bloodless before operation and very shocked afterwards. Within forty-eight hours of the operation, bronchopneumonia was present throughout the left lung, but, after pyrexia which lasted fourteen days, she made a complete recovery.

I do not advocate *high* spinal analgesia, so that, with one exception, I am unable to discuss the effect of paralysis of the intercostal muscles from this cause in the production of disorders of the lungs.

In an exceedingly stout woman, however, owing to the exaggerated recession of the lumbar curve, it was necessary to inject the tropæocaine solution into the lower dorsal region where the vertebral column approached most closely to the skin. High analgesia and loss of motor function to the fifth intercostal space was the result. The patient, without any increase in pulse-rate or respiration, became very cyanosed. Dr. Jonathan Meakins⁵⁸ points out that in spinal paraplegia involving the lower intercostal muscles carbon dioxide accumulates in the blood, and oxygenation is deficient. It is well known that lesions of the dorsal region of the spinal cord easily lead to bronchopneumonia. For other reasons, high spinal paresis is, perhaps, to be deprecated.

I am informed that some surgeons when performing gastrectomy are obtaining good results from paravertebral analgesia involving the eighth, ninth, and tenth dorsal nerves, but it is too early for us to form conclusions.

2. THE METHODS OF ADMINISTRATION OF THE ANÆSTHETIC.

When considering the effect of ether on the respiratory system, I enumerated certain essential points to be watched in the administration. In one respect the inexpert anæsthetist will spare his patient, for he will not give a very strong vapour lest an overdose occur. Thus, although satisfactory anæsthesia may not be attained in every case, great irritation of the respiratory epithelium from concentrated vapour will be avoided.

Open Methods and Closed Methods.—It is evident that the ideal method of administration will provide completely vapourized anæsthetic material of correct uniform strength. With this end in view, the late Joseph Clover some fifty years ago introduced his well-known closed ether inhaler. At one time it was suggested that this apparatus might be infected by patient A, and that the next patient, B, would be infected with the disease of patient A by the inhaler, but we should remember that ether is a mild antiseptic, and that a gauze mask soaked with ether, or a Clover's bag charged with strong ether vapour, is comparatively free from organisms.

Offergeld¹⁰ stated that animals anæsthetized by the closed method sometimes developed bronchopneumonia, whereas he had never seen bronchopneumonia follow anæsthesia induced by the open method. Wight¹² considered that ether dropped on a few layers of gauze reduced the number of respiratory troubles. Dr. T. L. Hardy,⁵⁹ at the Middlesex Hospital, found pneumonia

more frequently after closed methods than following administration on an open gauze mask. Vedin,¹⁶ who preferred simple methods, gave no preliminary atropine, and induced light anaesthesia by means of 'open drop ether.' Nevertheless, in 1915, after 1413 operations, there were 15 cases of pneumonia (1.06 per cent), and of the 15 patients attacked, 7 died.

There are plenty of doughty champions to support the cause of the closed inhaler. Silk said the closed inhaler was not a causal factor in this trouble, and he instanced the absence of lung trouble after administrations of gas. Acapnia, according to Yandell Henderson,⁶⁰ often resulted from open ether, and this was complicated by respiratory and circulatory depression, by post-operative vomiting, by intestinal paresis, and by gastric pains; therefore he advised closed methods. Dr. McCardie⁶¹ thinks there was not so much bronchopneumonia in the days when the Clover inhaler was used for routine work. Armstrong, of Montreal, had implicit faith in this method. At the Birmingham Ear and Throat Hospital, where it is the custom to administer ether by the Clover inhaler, post-operative pneumonia is comparatively rare, one or two cases occurring in each year.

The choice of method can play very little part in the causation of the disease which we are considering.

The Intratracheal Method.—Poppert³⁷ stated that, in dogs, intratracheal insufflation of strong ether vapour caused hypersection, hæmorrhage, and occlusion of the lung. Clearly these results are not applicable to man, because this means of administering ether approaches more closely to the ideal than any other. A regular supply to the lungs of ether vapour of minimal strength is constantly maintained, with the least possible exertion by the patient. Furthermore, when the intratracheal catheter has been inserted, and regular respiration is established, even in the absence of atropine, there is no salivation.

For operations on the tongue and jaw, anaesthetists agree that the introduction of the intratracheal method has reduced the risk of aspiration pneumonia. My last 20 cases of this class did not suffer from pneumonia.

Of course, the intratracheal technique does not entirely prevent pneumonia. I have seen pneumonia follow intratracheal anaesthesia for mouth operations, for thyroid operations, and for operations on the stomach. On the other hand, this complication has not appeared after intratracheal anaesthesia, in my practice, during a period of twelve months. I attribute the improvement to (a) chance, and to (b) permitting the cough reflex to return before releasing positive pressure by withdrawing the catheter. In this way I have avoided collapse of the trachea or of a bronchus, which might have led to partial or total collapse of the lung. In this connection the following case notes are of interest :—

Case 1.—B. G., male, age 35. Acute enlargement of the thyroid gland, threatening suffocation. Hemithyroidectomy was speedily performed under intratracheal ether, and the catheter was removed immediately after completion of the operation. During the next forty-eight hours he suffered from attacks of cyanosis. Occasional delirium, with pyrexia, accompanied by reduced entry of air, and râles at the right base, ensued. On the seventh day after operation, the pulse-rate fell suddenly from 100 to 80, and the temperature to normal. This patient's expectoration was scanty. In view of his condition it was deemed inadvisable to radiograph the chest, but I am inclined to think that the attacks of cyanosis, the scanty expectoration, and the sudden recovery were signs of collapse of the lung, initiated, in all probability, by collapse of a bronchus or of the trachea after premature removal of the catheter.

Intratracheal insufflation of ether will not prevent the onset of every variety of pneumonia, nor will collapse of the lung always be avoided, but the technique, if wisely employed, will reduce the incidence of post-operative pneumonia.

3. THE OPERATION.

We have now suggested certain principles in the choice of the anæsthetic and in its administration which it is certainly the duty of the anæsthetist to observe very closely, but his responsibility should not end here. Clearly, the anæsthetist should co-operate with the surgeon by keeping watch on the patient's condition before, during, and after operation, by preventing infection, and by sustaining the patient's strength. To the discussion of these topics we will now proceed.

Posture of the Patient during Operation.—The various attitudes in which patients are placed to obtain satisfactory access to the site of operation appear to have some bearing on the causation of lung complications.

When the patient is inclined head downwards in the Trendelenburg position, the risk of aspiration of infected material from the mouth and nose appears to be very small, but inversion of the patient causes the abdominal contents to press down upon the diaphragm, and there is some limitation of expansion in the lower lobes of the lungs. Nevertheless, pneumonia is rarely seen in gynæcological practice; at the General Hospital, only 4 cases of this complication occurred after 400 abdominal sections performed in the Trendelenburg position.

Patients lying horizontally on the back may aspirate material from the pharynx. Through the laryngoscope, on several occasions, I have witnessed the passage of mucus into the larynx. Children bleeding freely after tonsillectomy occasionally draw blood into the trachea, but, fortunately, expectoration expels it after a few moments. Of course, most surgical major operations are performed while the patient is lying in this position, and reference will be made to other points in this connection at a later stage.

The patient who lies face downwards for laminectomy or trephine of the occiput appears to run but little risk of aspiration pneumonia. Costal breathing must be rather restricted, but, in the comparatively few examples of these operations which I have seen, no lung trouble supervened.

I have records of a large series of nose and throat operations performed by Mr. Musgrave Woodman at the General Hospital upon patients seated upright in an operating chair. Dissection of tonsils, extensive nasal operations, excision of the superior maxilla, and intracranial operations, numbering in all over 200, have been done with only 1 case of pneumonia. Perhaps this low incidence may be attributed to the lessened tendency to loss of blood in this position, to careful hæmostasis, and, in the more severe procedures, to the employment of positive pressure intratracheal insufflation.

I believe the Trendelenburg position lessens the risk of aspiration pneumonia, but otherwise the position of the patient during operation is not an important factor in our inquiry.

Site of Operation.—Whatever may be the underlying cause in the production of pneumonia after operations on the abdomen, there is remarkable

agreement among all observers that laparotomy is the commonest forerunner of post-operative consolidation of the lung. Silk, Anders, Le Dentu, Læwen, Armstrong, Ranzi, Beckman, Isabella Herb, Hochenegg (quoted by Mandl), Homans, Cutler and Morton, Poppert, Elwyn, and Whipple have advanced strong evidence in support of this conclusion. Le Dentu quoted many series of abdominal operations recorded by German authors, in which the morbidity rate of pneumonia ranged from 4 per cent to 8 per cent. Læwen's rate was 6.6 per cent of gastric resections. Isabella Herb noted 9 pneumonias after 153 operations on the stomach (5.8 per cent). Poppert administered a mixture of 5 parts of ether with 1 part of chloroform for 812 operations of all kinds: 5 of the patients died, all with pneumonia, in each case after laparotomy. Whipple, in his series of 97 cases of pneumonia following operation, found that in 88 instances the abdomen had been opened. Elwyn's figures are very significant: in a series of 2932 operations, pneumonia occurred after 81 (2.7 per cent); 1080 laparotomies were complicated by 68 pneumonias (6.2 per cent), but 1852 operations on other regions showed a morbidity rate for pneumonia of only 0.7 per cent. Crouch and Corner, in their careful observations at St. Thomas's Hospital, noted 10 lung complications after 2400 administrations of ether, but no case of lung trouble after the employment of chloroform. They concluded that ether was the source of the trouble. Nevertheless, another explanation seems permissible, for 9 of the 10 cases of lung disease followed abdominal operations.

In the General Hospital records of 222 consecutive operations on the stomach, pneumonia appeared in 24 instances (10.8 per cent). 110 hysterectomies were followed by pneumonia in only 2 cases (1.8 per cent). Although, as I have said, the Trendelenburg position must lessen the incidence of pneumonia complicating hysterectomy, yet we may infer that an operation on the upper abdomen is more likely to cause lung trouble than surgical interference with the contents of the pelvis.

At the General Hospital, in 135 instances of post-operative pneumonia found at autopsy, 56 (41.4 per cent) were observed in subjects with recent operation wounds between the ensiform cartilage and the umbilicus. Of the remaining 69, at least 59 had died with large suppurating foci, and well-established septicæmia. Thus, in the absence of widespread sepsis, epigastric operations were the most constant forerunners of pulmonary disease. In 44 post-mortem examinations of epigastric operations at the Queen's Hospital, pneumonia was found in 22 (50 per cent), while in the whole series at this hospital the post-operative incidence was 35 per cent.

Although the mechanism whereby abdominal section predisposes to lung disease will be dealt with when considering the causation of massive collapse, and in other places, perhaps one point may be raised at once. Graham⁴⁶ has demonstrated the lowering of the opsonic index after saturation of the blood with ether; he has found that subcutaneous injection of lecithin or rectal administration of olive oil quickly restores the deficiency. Perhaps the shortage of fats in the diet of patients undergoing surgical treatment for stomach trouble may of itself produce a lowering of the opsonic index. During the war, the inhabitants of Europe were unable to obtain a sufficient supply of fat in their dietary, and many believe that the pandemic of

influenza and pneumonia spread and increased in virulence on that account. H. H. Brown⁶⁹ suggests that during the performance of gastro-enterostomy a pint of peptonized milk with egg and brandy should be introduced into the jejunum in order to reduce the period of starvation in this method of treatment.

Shock from Operation.—There is no need to discuss at any length the numerous hypotheses which have been elaborated to explain the cause of shock. We may, however, recall Crile and Mummery's earlier view that the vasomotor system was exhausted from prolonged irritation of the 'pressor' nerves, Yandell Henderson's asæpniæ theory, Boise's hypothesis of primary cardiac failure causing a fall in blood-pressure, and Meltzer's belief that the functions of the spinal cord were inhibited by the stimulus of injury. Since the war, Crile,⁶⁷ after extensive researches undertaken by himself and a considerable staff, both in America and at military hospitals in France, put forward the hypothesis that "the body as a whole was an electrochemical mechanism, the positive pole being the brain, the negative pole the liver, the connecting wires the nerves, the salts in solution the electrolytic fluid in which the electrochemical mechanism was immersed". Shock was alteration of electrical conductivity by impairment of the physical structure of the cell. Dale,⁶⁸ in his Oliver-Sharpey Lectures, described the presence in shock of stagnation of blood in the capillaries, and suggested that this may be produced by the circulation of certain toxic proteins. Cannon and others believe that injury to any part of the body sets free substances into the bloodstream, which cause this dilatation of the capillaries, thereby diminishing the return of blood to the heart, with a consequent fall in blood-pressure, although the arterioles are contracted.

We see that shock is produced by extensive injury to any of the tissues of the body, and particularly, therefore, to those such as the stomach, which are richly supplied with nerves or with blood-vessels. When the ill-effects of chilling and severe loss of blood are added to those of surgical trauma, marked predisposition to any process of general infection, such as pneumonia, must result. With this view most observers agree. In a letter to my colleague, Dr. McCardie, Sir Berkeley Moynihan emphasized the importance of handling all tissues most gently if lung complications were to be avoided.

Reference has already been made to a case of Cæsarean hysterectomy under spinal analgesia for profuse concealed intra-uterine hæmorrhage. Here no general anæsthetic was employed, the operation was rapidly performed, and harmful sensory impulses were blocked by the spinal anæsthetic. By far the most disturbing influence was the tremendous loss of blood both before and during the operation. One feels compelled to attribute the subsequent pneumonia chiefly to this factor. F. B., also mentioned previously, a woman of anæmic appearance, was admitted to the gynæcological wards with the diagnosis of 'ruptured tubal gestation'. Examination of the chest revealed widespread capillary bronchitis. The abdomen was opened under spinal analgesia, and a large quantity of blood was found throughout the peritoneal cavity. Salpingotomy having been performed, the blood-clot was removed. Next day bronchopneumonia was demonstrated in all lobes, but, happily, the patient recovered. In this instance loss of blood and irritation of the peritoneum

were the potent factors which, even before operation, had laid the foundation for the subsequent pneumonia.

Too often we forget the profound chilling of a patient's body which occurs during a long operation, while more or less exposed on an unheated operating table in a cold theatre. The man who gets caught in the rain on a cold winter's day, and then develops pneumonia, has not run nearly so great a risk. Some years ago, Robb⁷⁰ made a series of observations on the fall in patients' temperatures during operation, (a) on a cold table, (b) on a table heated by means of electric lamps placed under the table.

His results were as follows: 38 abdominal sections, room at 83°, no lamps, cold table, total fall of 25.8°; 38 abdominal sections, room at 78°, with lamps, heated table, total fall of only 10.6°.

Thus, in the second series, though the room was colder, the heated table considerably reduced the cooling of the body.

Vierordt, quoted by Isabella Herb, states that 11 calories per hour are lost by the normal lungs, but 90 calories per hour are lost by the skin: so that we must endeavour to prevent loss of heat by the skin.

Corlette⁷¹ pointed out that the loss of heat by convection from the body depends on the free movement of air over the skin. Warmth then will be conserved provided that the covering be air-tight, free from gaps. Dr. S. R. Wilson⁷² has suggested an operating suit embodying this principle.

Dr. McCardie suggests that the free perspiration and the red flush produced in the skin during the administration of ether must lead to particularly rapid loss of heat, so that patients who are under the influence of ether must be kept dry and well covered.

Lastly, the custom of purging patients before operation lowers the blood-pressure, but pre-operative rectal salines are most helpful.

Chilling of the Body during Transit back to the Wards and during Recovery from the Anæsthetics.—"It is a cold wind with a moist atmosphere which chills you to the bone, and finds out the weak spots in your anatomy". In these words Sir James Barr⁷³ indicates the determining factor in many a case of bronchitis or pneumonia.

After operation the patient, often imperfectly clothed, and bathed in perspiration, is taken on an ambulance along cold corridors, and maybe in a draughty lift, to the ward, where the bedclothes are tossed off during the restless recovery, and, owing to the shortage of nurses (particularly at night), they are not immediately replaced. Dr. McCardie has reminded us that the thermic centre is out of balance in these cases, and this leads to failure to conserve heat. Recently Dr. Mennell told me of an epidemic of lung complications after operations which had recently occurred at St. Thomas's Hospital. At the time of the epidemic, the hospital was undergoing alterations which necessitated the transport of patients through long corridors, where they were exposed to outside weather conditions. Dr. Mennell attributed the epidemic to the chilling of the patients at this time.

Dr. Lamb has remarked that, in order to prevent chilling of the patient during the stages of preparation, operation, and recovery, great care must be exercised in regard to detail, otherwise the unconscious patient may quite readily undergo loss of heat to a fatal extent. As mentioned above, Corlette

insists on the need of carefully covering the patient so that no draught can play on the skin. Draughts give rise to vasomotor disturbances, and in the conscious patient this leads to shivering, but under anæsthesia, although the risk is greater, no danger signal is forthcoming.

Dr. Silk in 1900 considered it dangerous to place the patient's bed in a draughty part of the ward, and I understand that he is still of this opinion. At the General Hospital, where the plenum system of ventilation is in use, Dr. McCardie suggested to me that the breeze produced by opening the door of the ward led to an abnormal number of colds and lung complications among the patients who occupied those beds over which the current of air swept. He specified the second, third, fourth, and fifth beds on the right of the ward, counting from the entrance doors. Thereupon, in several of the wards, I conned the sisters' daily reports for the year 1923. But coughs, colds, and even pneumonia, so far as I could see, did not threaten the occupants of certain beds more than the patients in others. Nevertheless, a strong draught is not desirable, and Dr. McCardie is widely supported in his advocacy of small, warm rooms, with open fires and closed windows, for the first twenty-four hours after operation.

Bearing in mind this need of perpetual vigilance by a skilled nurse, and of still air at a constant temperature, some hospital authorities (e.g., at the Bristol General Hospital) have instituted small recovery wards in immediate proximity to the operating theatres, where these conditions may be observed for twenty-four hours after operation. The results are not, as yet, conclusive, and I understand that this is mainly due to difficulties in organization.

4. THE PATIENT'S GENERAL CONDITION.

Influence of Sex.—When pneumonia occurs in patients who have not undergone surgical operations, it is found that men are more frequently attacked than women. Osler stated that he had records of a series of the lobar variety in which 533 men had suffered, but only 125 women, that is to say, a ratio of about 4:1. He did not, however, mention the influence of sex in the causation of bronchopneumonia.

At the Birmingham General Hospital, during two years, secondary bronchopneumonia was found in 89 autopsies from the medical wards. Of these, 57 were male and 32 were female, giving a ratio of approximately 2:1. Of the post-operative autopsies, bronchopneumonia was found in 104 men and 34 women, i.e., 3:1. (It must be pointed out that the numbers of operations performed on men and women at the hospital are about equal.) When, however, we examine the results of operations on the upper abdomen, as demonstrated by my series of 222 operations on the stomach, we find that after 165 operations on the stomach in men, bronchopneumonia occurred in 22 (13·3 per cent); and after 63 operations on the stomach in women, bronchopneumonia occurred in 2 (3·1 per cent). Supposing that equal numbers of operations had been performed on men and on women respectively, we should get pneumonia occurring in the ratio of more than four men to one woman.

In the literature, opinions on this point, as on other questions, are divided. Anders' said that sex was not a factor, and the chairman of the Surgical Congress of the American Medical Association in 1909 stated that "age and

sex play no part"; but Whipple has records of 128 cases of bronchopneumonia after operations on men, as compared with 36 cases of the disease in women. Isabella Herb, in 1922, published a careful analysis of 107 cases of post-operative lung complications. 76 in men and 31 in women. All the lung complications occurring after operations on the stomach and appendix were in men; after gall-bladder operations, 6 were in men and 4 in women; and after hernia operations, 8 were in men and 1 was in a woman. The remaining cases were either septic or terminal. On consideration of the relatively high frequency of bronchopneumonia after operation on men's stomachs, both in my series and in those of others, one must conclude that men are particularly susceptible to bronchopneumonia when the upper abdomen is injured.

It is reasonable to suggest that the abdominal or diaphragmatic type of respiration in men plays some part in determining the onset of bronchopneumonia. Thus, during upper abdominal operations a man sustains direct and reflex shock to the diaphragm; this leads to partial paresis of that muscle. After recovery from the anæsthetic the patient finds difficulty in coughing and in deep breathing, because the diaphragm is weak and the abdominal respiration leads to increased movement and tension in the wound. Women are not so seriously troubled, for adequate costal breathing does not disturb the abdominal wound, and even coughing may be indulged in without serious pain.

Influence of Age.—J. M. Anders, writing in 1898, considered age to be an unimportant factor, but Silk⁶ pointed out that most cases of bronchopneumonia after operation occurred in persons under 40 years of age. In an analysis of his series, Whipple¹⁷ found that in each of three years this complication occurred most frequently in patients between 30 and 40 years old, but, according to Cutler and Morton,⁴⁴ old age gives a strong predisposition.

The age incidence in my series of autopsies is shown in *Table III*.

Table III.—AGE INCIDENCE OF PNEUMONIA IN MEDICAL AND SURGICAL CASES.

AGE IN DECADES	NUMBER OF SURGICAL CASES WITH PNEUMONIA	ORDER OF FREQUENCY	NUMBER OF MEDICAL CASES WITH PNEUMONIA	ORDER OF FREQUENCY
0-9	19	4	23	1
10-19	16	7	11	3
20-29	15	8	10	5
30-39	17	6	14	2
40-49	30	1	11	3
50-59	22	2	10	5
60-69	21	3	9	7
70-80 and upwards	19	4	1	8

Thus, if any inference can be made, we may notice that, in the surgical cases, pneumonia was commonest in the latter half of life; while, in the medical autopsies, the younger subjects had been more frequently attacked. But hypostatic pneumonia in the aged, and the greater severity of operations

performed on those in middle life, may account to some extent for the relatively high incidence in the more elderly. These figures do not differ greatly, and, we conclude that pneumonia may complicate operations performed at any age.

5. GENERAL SYSTEMIC DISORDERS AFFECTING METABOLISM AND ORGANS OF DEFENCE.

Nutrition.—In general, surgeons find that chest complications occur more frequently after operations on hospital patients than in private practice. To some extent we may attribute this to the state of nutrition, and it is of interest to consider a series of operations at the Birmingham Children's Hospital, performed on wasted infants for congenital hypertrophic pyloric stenosis. These cases were under the care of Dr. Leonard Parsons, and the results were embodied in his Goulstonian Lectures⁷⁴ for 1924. At this hospital there is a ward for private patients, but the conditions of operation, nursing, and treatment are the same for both 'private' and 'hospital' cases. In a series of 70 infants operated upon, of whom the majority were treated by the same surgeon and the same anaesthetist (Mr. Seymour Barling and myself), 59 were from the poorer classes, and 11 were private cases. The death-rate for the poorer-class patients was 56 per cent, but there were no fatal cases among the better-class babies. Bronchopneumonia occurred with fatal results in 5 of the hospital cases, but there was no instance of this complication among the infants from the private wards. It was very evident, from the weight and state of nutrition of the babies, that the well-to-do parents had secured diagnosis and treatment at an earlier stage than the working-class parents, and to this more advanced wasting I think we may ascribe the much higher post-operative morbidity and mortality in the poorer-class infants.

Phagocytosis.—In an unpublished research on prognosis in suppurative appendicitis, Dr. Piney, the present Director of the Charing Cross Hospital Pathological Department, concluded that the presence of leucopenia at the time of operation foreshadowed delayed recovery or death, but, on the other hand, a high leucocyte count justified an optimistic prognosis. He suggested that, in patients with leucopenia, the pre-operative administration of sodium nucleinate would induce a protective leucocytosis against pneumonia. However, working on cats, certain observers have produced leucocytosis by this means, but they state that the leucocytes are not active phagocytes. Unfortunately, in routine practice the method is not practicable, and I have not had any personal experience.

Drugs.—The phagocytic action of the blood is diminished by the presence of ether, but the rectal administration of olive oil is said to re-activate the phagocytes.⁴⁶ This deleterious action of ether (and chloroform) seems to last but an hour or two.

In the case of chronic alcoholism, however, there is much evidence that the defensive mechanism of the body is seriously crippled. Capps and Coleman²⁸ have published an interesting analysis of 3422 cases of lobar pneumonia at the Cooke County Hospital, Chicago. These cases occurred during two periods, namely 1911-17, before prohibition was enforced, and the two years after prohibition, 1921-22. They found that the death-rate

in moderate drinkers was much higher than among abstainers, and that in excessive drinkers the death-rate was highest of all. Speaking as an anæsthetist, I should say that men who have persistently drunk alcohol to excess require large amounts of the anæsthetic agent to anæsthetize them, that they are much exhausted after operation, that they readily catch cold, and easily develop pneumonia, and that, when this happens, the death-rate is very high.

Cachexia.—With the onset of old age, the physiological processes of the body lose their vigour, the germs of pneumonia readily obtain a foothold, and then the outlook is always most grave.

Anæmia leads to abatement of the body's activities with similar results, and, on looking through the medical post-mortem records, this is confirmed.

Cachexia from Cancer.—In the majority of cases cancer is terminated by the onset of bronchopneumonia. Læwen⁹ recorded pneumonia in 36 per cent of his series of gastrostomies for cancer of the œsophagus, but only in 6.6 per cent of resection of the stomach.

In my list, of 5 autopsies on patients who died after gastrostomy for cancer, bronchopneumonia was present in 4. General anæsthetics had been administered to 3, all of whom had had bronchopneumonia, but the other 2 subjects had been operated on under local analgesia, and 1 of these exhibited bronchopneumonia.

In general, it is my experience that, although local anæsthesia does perhaps reduce the rate of incidence, the majority of gastrostomy cases which are examined after death exhibit bronchopneumonia, whether the anæsthetic was general or local.

The Influence of Heart Disease and Circulatory Failure.—Elwyn²⁶ held that cardiac exhaustion might lead to congestion of the lungs and hypostatic pneumonia, this being one explanation of the distribution of the disease in the lower lobes. He recommended the early use of digitalis, and this is now the custom in the clinics at Vienna. Mandl²² administers the drug within fifteen minutes of the end of the operation. Kellogg,³² too, believes in the danger of pulmonary congestion. After operation he repeatedly applies cold compresses to the chest and massages the body to encourage a free circulation of the blood. Ranzi,⁶⁶ and also Le Dentu,¹⁰ suggest that pulmonary stasis may lead to the formation of minute emboli, and they recommend deep breathing and free movements of the limbs, commencing as soon as possible.

It might be thought that anæsthetic drugs (and especially chloroform) would have a toxic action on the heart and induce stagnation of the blood, but in fact emboli occur very rarely on the day of operation, and nearly always after the third day.

A slow pulse-rate does not appear to lead readily to pneumonia. I have notes of two patients with heart-block, in whom the pulse-rate was usually about 40 per minute, whom I anæsthetized for prolonged operations, without any untoward sequel.

My own view is opposed to blaming weak hearts or bad circulation for the onset of the complaint under discussion. I do not remember any case of bronchopneumonia following shockless operation on patients suffering from heart disease, even though they were prolonged.

In the post-mortem records, I find that of 33 subjects from the medical

side who had died of infection or of ulcerative endocarditis, of acute or chronic myocarditis, of mitral stenosis, or of congenital morbus cordis (excluding cases with associated renal disease), pneumonia was present only in 8. This corresponds to the pneumonia incidence for the whole series of medical autopsies, i.e., 25 per cent. In many instances, non-infected infarcts were present in the lungs, but there was no pneumonia.

6. THE PRESENCE OF PULMONARY DISEASE PRIOR TO OPERATION.

During the war, when serving in Salonika, I learnt that surgical patients previously infected with the malarial parasite often sustained an attack of malaria within the forty-eight hours following operation. Similarly, in April, 1918, during the fighting round Villers-Bretonneux, many men reported sick who were found to be suffering from malaria. These fellows had been worn out by the disheartening and exhausting retreat from St. Quentin, and, when I saw them, they had been soaked for two days by drenching rain, food was scanty, and the outlook most depressing. Every one of the men had served in the East, and gave a history of previous malarial infection. Exhaustion enabled the parasite to develop once more.

It is acknowledged that pneumonia may attack the same individual on several occasions, and we believe that each attack renders the patient rather more susceptible to the complaint.

In view of these considerations, and of numerous examples of the trouble, many authorities agree that a patient who has undergone pneumonia during the year or two prior to operation is in danger of sustaining an attack of post-operative pneumonia. Graves⁶⁴ believed this to be most important, and Chapman, and Cutler and Morton, concur.

Silk, writing in November, 1920, draws attention to the importance of a recent history of severe influenza, and *Table IV* gives support to this view:—

Table IV.

INFLUENCE OF RECENT INFLUENZA ON POST-OPERATIVE PNEUMONIA.

AT THE GENERAL HOSPITAL	1906, i.e., before INFLUENZAL PANDEMIC	OCT. 1918— AUG. 1919, i.e., during INFLUENZAL PANDEMIC	1920-1922, after INFLUENZAL PANDEMIC
Surgical autopsies	150	150	385
Cadavers showing pneumonia ..	42	66	138
Incidence of pneumonia, per cent ..	28	44	35.84
Medical autopsies	124	100	350
Cadavers showing secondary pneumonia	27	32	89
Incidence of pneumonia, per cent ..	21.7	32	25.42

Thus, in death-dealing disease, both after operation and without operation, pneumonia occurred with much greater frequency during the influenzal pandemic than before it; and even during the last two or three years the incidence was higher than it was in 1906.

The following cases which have come under my notice strengthen my belief that former inflammation of the lungs, though not detected on physical examination by the anæsthetist, readily lights up when the patient is subjected to general anæsthesia and a surgical operation.

Case 2.—T. C. B., male, age 51. Bronchopneumonia, in the summer of 1921, followed by recovery. In the spring of 1922, gastro-enterostomy was performed, pneumonia developed within forty-eight hours, and the patient died on the fifth day. At the time of operation the patient appeared to be in good general health, and the operation was not unduly severe.

In addition to those here given, I have notes of 7 patients, all of whom recovered, who gave histories of previous attacks of pneumonia, and who developed pneumonia after gastro-enterostomy (3), hysterectomy (1), and appendicectomy (3).

* *Case 3.*—M. C., female, age 46. In 1906, anterior gastro-enterostomy was performed with a Murphy's button. Bronchopneumonia developed in both lungs, but the patient recovered.

In 1920, a plastic operation on the stomach was followed by transient lung trouble, which did not call for much attention.

In 1922, in the presence of massive adhesions, and with great difficulty, pylorectomy was performed for a large ulcer near the pylorus. The operation took two and a quarter hours, open ether being administered for the first hour, and gas and oxygen for the remainder of the time. The patient was very collapsed at the end of the operation, and transfusion with gum solution was resorted to. However, she did not rally, and death occurred on the third day. At autopsy extensive bronchopneumonia was found in both lower lobes. (There were no coughs or colds in the ward at that time.) When the patient was first seen at the hospital during an acute attack in 1906, before any operation was performed, the pulse-rate was 56 to 60 per minute. Treatment by rest in bed with a suitable diet caused the pulse-rate to rise to 76 to 80.

I regard this case as an instance of vagal reflex action from the stomach affecting the heart, and probably promoting some degree of bronchiolar spasm. However, I shall return to this point when considering bronchiolar spasm and collapse of the lungs.

The combination of heart disease (such as mitral stenosis) and a history of previous attacks of pneumonia appears to be very important.

Case 4.—S., female, age 32. History of three or four attacks of bronchopneumonia. Double mitral disease. Primigravida in poor condition, Cæsarean section performed under open ether at term. Delivered of twins. Operation was quickly done in twenty minutes, with only slight loss of blood. Bronchopneumonia appeared at both bases on the third day, and death occurred on the seventh.

It is agreed that patients who have suffered from phthisis may undergo exacerbation of the disease as the result of operations.

Case 5.—A. B., male, age 25. History of tuberculosis, healed patch in right apex. Uneventful operation for cure of right inguinal hernia, and appendicectomy, under open ether. He commenced to cough on the third day, and tubercle was found in sputum. The cough disappeared by the tenth day.

The following notes on two patients of the same sex, type, age, who were nursed in adjoining beds, and who underwent similar operations under similar anæsthetics on the same morning, afford striking testimony

to the importance of old-standing lung disease in the determination of pneumonia after operation.

Case 6.—W. P., male, age 40. Previous history: healthy, spare build, good general condition. Duodenal ulcer. Gastro-enterostomy and appendicectomy were performed uneventfully under open ether. Collapse of part of the right lower lobe appeared on the fifth day (confirmed by X-ray examination), but no pneumonia could be found. Symptoms: slight cough, good colour. Pulse-rate never above 88, remittent temperature to 101° on third to seventh days inclusive. Respirations did not exceed 28 per minute. Quite well on the tenth day.

Case 7.—G. H., male, age 35. Bronchopneumonia eight months previously. Good general condition. Duodenal ulcer. Gastro-enterostomy and appendicectomy were performed uneventfully under open ether. 'Chesty' after operation. Definite right basal bronchopneumonia on the fourth day. Recovery.

I think that both these men suffered from collapse of the lower lobe of the right lung, but pneumonia developed only in the lung which contained the remains of old infection.

7. THE PATIENT'S RESPIRATORY SYSTEM.

The Influence of the Shape of the Chest—For the most part, the shape of the chest can have but an indirect influence in the causation of pneumonia, and any disease of which the shape of the chest is symptomatic will have the more marked effect.

In emphysema, however, where respiration is often carried out entirely by the diaphragm, interference with the free movement of this organ, as in operations on the upper abdomen, may lead to hypostatic pneumonia and, it may be, to collapse of the lungs. It should be noted that closed methods of administration of anæsthetics to emphysematous patients, in particular, will tend to defective aeration and consequent impairment of the physiological activities of the lung tissue.

The Influence of Chilling of the Lungs.—The entry of cold air into the lungs acts in two ways.

a. The body as a whole loses a considerable amount of heat. Isabella Herb,²¹ quoting Vierordt, says that normal lungs lose 11 calories per hour, but the skin loses 90 calories of heat in each hour. Owing to the number of variants involved in the calculation, I think these figures give only a general indication. Corlette, in the article already quoted, points out that cold damp air chills the lungs less than warmer air which is dry, for much heat is lost in the evaporation of water to saturate the dry alveolar air with water vapour.

b. Joss⁷⁶ found that, during anæsthesia, the inspired air was at least 33° below room temperature, and he considered that the chilling reduced the bactericidal action of the lung and slowed the movements of the ciliated epithelium.

I have already mentioned the danger of inspiring a fog of droplets of ether, which must cause serious interference with the normal action of the alveolar epithelium, both by chilling and by chemical action. Shipway, in strong support of the warming of anæsthetic vapours, says that the warming of ether vapour prevents its reputed irritation of the lungs.

Silk,⁷⁵ at Malta, found that hot open air in the operating theatre and

afterwards went a long way towards abolishing lung troubles. Operations in one of the theatres which was ill-ventilated, and heated by gas fires, were frequently followed by lung complications. Silk considers therefore that the temperature and quality of the inspired air are of first importance.

The Influence of Free Secretion.—In many persons, the inhalation of ether vapour for anæsthetic purposes induces free salivation and secretion of watery mucus by the mouth, nose, and pharynx. (Some individuals, notably infants, do not secrete so vigorously.) This secretion is accompanied by a profuse outpouring of sweat by the skin, and many authorities contend that the evil effects of ether lie in aspiration into the lungs of germs contained in mucus from the nose and mouth, and in the loss of bodily heat occasioned by the evaporation of sweat. There is much to be said for this view, and the practice, now almost universal, and certainly most valuable, of injecting $\frac{1}{100}$ to $\frac{1}{50}$ gr. of atropine half an hour before operation, has prevented the secretion; yet post-operative lung troubles still occur. On the contrary, one sees ill-prepared patients in the out-patient theatre 'frothing' vigorously under ether anæsthesia, the atropine injection having been omitted; but pneumonia in these and similar cases is extremely rare.

Nevertheless, the dry patient is warmer, more readily anæsthetized, of a better colour, and far less shocked after the operation: all of which must militate against lung infections.

The Influence of Patency of the Upper Air-passages.—We all agree that a clear airway is essential to effortless respiration, but laryngeal spasm, or a congested tongue, or falling back of the jaw, may start the vicious circle which leads to cyanosis, and so back to more spasm or more congestion. Obstruction to respiration entails great fatigue of the muscles of respiration, and hinders the elimination from the blood of waste products, thus leading to cardiac exhaustion and pulmonary congestion. But, notwithstanding the care with which anæsthetists remedy this defect, pneumonia does occur after uneventful and effortless anæsthesia, while badly administered anæsthetics with cyanosis do not raise the frequency of pneumonia to any remarkable extent.

We must conclude that partial obstruction of the airway is not a primary cause of lung trouble.

The Effects of Interference with the Movements of Respiration.—The most direct means of limiting respiratory movements is by mechanical compression of the thoracic wall. Thus, after some operations, the chest is constricted by an abdominal binder. Dr. Flemming, of Bristol, told me that he had seen a patient, who had just undergone laparotomy, bound up so tightly that he was blue and nearly pulseless for an hour or more. Loosening the binder led to instant relief and a normal appearance, and lung trouble did not follow. Again, the majority of patients upon whom the modern radical method of removing a carcinomatous breast is performed awaken to find that the wound has been covered by skin stretched so tensely as to resemble parchment, and that the chest is held in a vice-like grip. Similarly, the free rise and fall of the diaphragm is obstructed by marked increase in bulk of the abdominal contents, e.g., meteorism, large ovarian cysts, pregnancy, ascites.

Now, several authors have suggested that limitation of movements by the chest wall from any cause whatsoever is a potent factor in the production

of pneumonia. With this general view of the matter one cannot entirely agree. If we consider the results of mechanical constriction of the thorax produced by the methods outlined above, we must confess that pneumonia is very rarely seen after the most extensive operations on the breast, however firmly the thorax be compressed by tight stitching; nor does pneumonia appear as a frequent complication of abdominal ascites, pregnancy, or meteorism in the absence of an operation. To my mind, then, although pulmonary hypostasis is promoted by this means, some degree of limitation of movement of the chest does not of itself lead to massive collapse of the lungs.

Massive Collapse of the Lungs.—As is well known, the credit for the pioneer work on this subject is due to William Pasteur.^{77, 78, 79} In his Bradshaw Lecture of 1908, Pasteur said that cases of post-diphtheritic paralysis of the diaphragm developed airlessness, more or less complete, in one or both lower pulmonary lobes.

Keith⁸⁰ had shown that the upper lobes were distended principally by movement of the ribs, while descent of the diaphragm expanded the lower lobes. In Pasteur's opinion, paralysis of the intercostal muscles, or of the diaphragm, on one or both sides, led to deficient expansion, and often to complete airlessness of the corresponding lobes. Together with other observers, including D. J. Harries,⁸¹ he records the frequent occurrence of partial or complete diaphragmatic paresis, more usually of the right leaf, as a sequel to laparotomy.

The diagnosis of post-operative partial diaphragmatic paresis is not easy. The most reliable means, radiography, is rarely available. In most hospitals, the portable apparatus for ward work is not of sufficient power to permit of screening. Furthermore, as a routine, one is not justified in disturbing the patient immediately after operation by the journey to the radiologists' department, in order to make an examination which may be chiefly of academic interest. Clinically, before there is any marked change in the lung, we may bear in mind that relaxation of the right leaf of the diaphragm leads to a rise in the liver dullness, and relaxation of the left half of the diaphragm permits the heart to move towards the left clavicle, while paresis of the intercostal muscles allows of descent of the liver, or of the heart, as the right side or the left side, respectively, is affected.

In this connection, the presence of Hoover's⁸² sign may be sought. Normally, on inspiration, the subcostal angle is widened, because the intercostal muscles, in their efforts to broaden the chest by the bucket-handle movement of the ribs, gain the mastery over the diaphragm, which tends to narrow the thorax, but which, owing to its curved form, acts under mechanical disadvantage. Should, however, the diaphragm be paralysed, the unopposed intercostal muscles cause the chest to be even broader, and on inspiration the subcostal angle will widen to an exaggerated extent. Paralysis of the intercostal muscles, on the other hand, allows of unhampered action by the diaphragm, and inspiration narrows the subcostal angle. If paralysis is unilateral, these abnormal movements are limited to the affected side. However, in practice, one-sided paresis renders the sign somewhat uncertain. We may note that bilateral diaphragmatic paralysis gives rise on inspiration to recession of the epigastrium as contrasted with normal protrusion.

Many careful observers agree that relaxation of the diaphragm does take place with great frequency in any abdominal condition entailing pain sufficiently great to cause reflex spasm of the muscles of the anterior abdominal wall, whether the source of pain be peritoneal inflammation or an operation wound. Usually the right half of the diaphragm alone is involved. The upper eight intercostal muscles are rarely disturbed, although, for reasons I shall suggest, spasm of the ninth and tenth intercostal muscles may occur.

By what mechanism is this change in the action of the diaphragm brought about? In other words, have we to deal with direct injury to the diaphragm, or is there reflex inhibition? Relaxation of the diaphragm has been recorded in many cases of operation for appendicitis or for radical cure of an inguinal hernia, although the neighbourhood of the diaphragm had not been explored. Almost certainly, we have to deal with a reflex inhibition of which one or both of the phrenic nerves is the efferent path.

There are differences of opinion as to the afferent nerves involved. Pasteur suggested that the vagal afferent fibres were implicated; but there is no proof that stimulation of the central end of the divided vagus can produce reflex inhibition of the diaphragm; nor are extensive operations on the neck, which involve much handling of the vagus, responsible for diaphragmatic paresis, although persistent vomiting, due to stimulation of the vagus, often follows these operations. Hardy, and also Harries, arguing on Sherrington's law of synergic co-operation between a muscle and its antagonist, very reasonably suggest that increased tone of the protective muscles of the anterior abdominal wall is excited by inflammation such as appendicitis and peritonitis, or by a surgical wound, and that the diaphragm, which in this instance is the antagonist, is relaxed. That this does in fact occur is the experience of surgeons when they open the abdomen for perforation of a gastric ulcer. One finds that the stomach and bowels lie limply on the posterior wall, almost without the usual movement due to respiration, and it is rare indeed, before meteorism has set in, that the surgeon has trouble with protrusion of the abdominal contents through the wound. This phenomenon, I think, must be due to abnormal quiescence (i.e., inhibition) of the diaphragm. According to this hypothesis, the afferent paths are the sympathetic sensory fibres from the inflamed area.

Before leaving the subject, I will recall two cases which presented points of interest.

Case 8.—T. M., Male, age 50. Perforated duodenal ulcer.

Grave condition, complicated from the anaesthetist's point of view by enormous bilateral adenomata of the thyroid. High injection of spinal anaesthetic was administered into the ninth dorsal space. The operation proceeded uneventfully until the surgeon explored the under surface of the diaphragm, whereupon the patient cried, "You are hurting my right shoulder". This was an instance of direct injury to the diaphragm and of simple phrenic reflex. The patient died sixty hours after operation, and autopsy revealed oedema and congestion of the lower lobes. In this case some paresis of the diaphragm was present at operation.

Case 9.—M. W., Female, age 55. Operation for incarceration of the bowel and omentum in a left inguinal hernia sac.

The presence of severe bronchitis caused me to induce spinal analgesia as high as the umbilicus. The patient talked cheerily until, as the surgeon delivered the

hernial sac, with its contents, she exclaimed, "You are crushing my chest". The discomfort was limited to the lower region of the thorax. Reduction of the incarcerated omentum and small bowel soon relieved her, but vigorous manipulation of the sac did not cause sensation of any kind.

I think the afferent path of this reflex was the sensory sympathetic fibres of the lower intercostal nerves.

H. E. Griffiths⁸³ recalls that the peritoneum covering the gall-bladder and the pyloric end of the stomach receives its nerve-supply from the fifth to the tenth dorsal nerves, from the right phrenic nerve, and from both vagi. Here at least are plenty of different afferent paths for reflexes to the lower intercostal muscles and to the diaphragm.

When working in France with Professor Gask, my colleague, Dr. K. D. Wilkinson, observed unilateral and even complete diaphragmatic paresis in men severely wounded by bullets or shell fragments in any part of the body. In these conditions any sensory nerve may supply the afferent path of the reflex under discussion.

Having established the fact that relaxation of the diaphragm does most frequently occur after operations on the abdomen, we must inquire what happens to the lung whose expansion, Keith says, is controlled by this muscle.

It has been observed by Pasteur and others that often the lower lobe on the affected side becomes airless, and that the collapsed region of the lung usually produces the following symptoms and signs:—

a. Onset, sudden or gradual, occurs usually with distress on the first, second, third, fourth, or fifth day after operation.

b. Sputum of varying type appears some hours after the onset of massive collapse.

c. Mobility of the affected region is decreased.

d. There is retraction of the rib spaces over the collapsed area of the lung.

e. The breath sounds are inaudible over the diseased area.

f. Tubular and bronchial breath sounds are heard above the affected area.

g. The heart is displaced towards the side of collapse. Pasteur believes this to be pathognomonic of the condition.

h. Temperature, pulse-rate, and rate of respiration are raised.

The rate of onset may be quite gradual or it may be very sudden. And this applies to recovery. The most striking example that I have seen took a week to develop and several months to recover.

Case 10.—A. L., Female, age 16. Right hemithyroidectomy for parenchymatous goitre.

Uneventful operation under open ether. There was slight 'chestiness' from the first day, which gradually increased until on the sixth day the patient complained of great pain on the right side of the chest, and dyspnoea with cyanosis. Examination of the chest at that date showed: (*a*) Almost complete absence of movement on the right side; (*b*) Retraction of the right rib spaces on inspiration; (*c*) Apex beat two inches internal to the left nipple line; (*d*) Dullness on percussion up to the second right rib; (*e*) Complete absence of breath sounds over the lower two-thirds of the right portion of the chest, with bronchial breath sounds over the upper third.

Radiography showed complete paralysis of the right half of the diaphragm, with opacity of the right lower and middle lobes and the inferior half of the upper

lobe. There was ascent of the paralysed diaphragm on inspiration, and descent on expiration. Remittent high temperature and quick respiration and pulse-beat continued for three weeks, and returned gradually to normal. There was no definite bronchopneumonia. We suspected that the paresis of the diaphragm was due to some permanent lesion to the right phrenic nerve, possibly from direct injury or from extravasation of blood. I have related this case at some length, for the clinical picture was most impressive. (Later: The patient recovered. A second operation was undertaken six months later for further removal of the thyroid, under ether. Uneventful recovery followed.)

We have agreed that transient paresis of the diaphragm often escapes notice, and the same result must apply to partial collapse of the lungs, which does not give rise to subjective symptoms.

At the Middlesex Hospital, during the period 1906-12, Pasteur and Hardy found 28 instances of massive collapse of the lung, which were noted in a series of 5594 operations on the abdomen or kidneys. The majority of these cases followed sub-umbilical operations. I have records of 12 patients who developed the condition (*Table I*).

Table I.—MASSIVE COLLAPSE OF THE LUNG FOLLOWING OPERATION.

OPERATIONS	TOTAL NO.	MALE	FEMALE	SIDE OF COLLAPSE			DAY OF ONSET	RESULT
				L.	R.	BOTH		
Right inguinal hernia	4	4	-	-	4	-	1st, 4th 3rd, 3rd	All cured
Hemithyroidectomy	2	-	2	-	2	-	1st, 7th	Both cured
Appendicectomy	2	1	1	1	1	-	2nd, 2nd	Both cured
Gastric operations	4	3	1	-	2	2	1st, 2nd 2nd, 7th	Two pneumonia, died; one pneumo- nia, one collapse, lived

As is customary, only those patients died who had developed pneumonia. for massive collapse of itself is not of grave import. With regard to the site of operation, 7, including the thyroid cases, were above the umbilicus, and 5 were sub-umbilical.

In this list, I include only cases which at some stage showed lung collapse apart from pneumonia. It is extremely probable that massive collapse is the precursor of many cases of post-operative pneumonia, but the condition is often overlooked until pneumonia supervenes.

Opinions are still divided as to the cause of massive collapse of the lung. Pasteur, as we have seen, traces the course of events: abdominal section, diaphragmatic inhibition (of shorter or longer duration), collapse of one or both lower lobes of the lungs, and then, in some cases, pneumonia. Elliott and Dingley,⁸⁴ however, on clinical and experimental grounds, believe the starting-point is plugging of the lesser bronchioles with mucus, and a generalized bronchitis. Then the air in the associated alveoli is absorbed (Lichtheim's experiments⁸⁵) and the lung collapses, drawing the heart towards the shrunken lung. These observers conceive that arrest of unilateral or bilateral diaphragmatic or intercostal movement may occur from reflexes of intrathoracic origin.

Important as these suggestions are, one is induced to adhere rather to Pasteur's view. On Elliott and Dingley's hypothesis, we should expect bronchitis to be common, and pneumonia to occur at any region of the chest. But capillary bronchitis is far from common after operations, whilst pneumonia in these cases is rarely diffuse, and nearly always in the lower portion of the lung.

A further suggestion has been made by various observers, who consider that spasm of the bronchial musculature may lead to secondary collapse of the lungs, as shown experimentally by Brodie and Dixon.⁸⁶ Colour is lent to this view, if we reflect on the vagal reflex by which, in an analogous manner, gastric inflammation lowers the pulse-rate, and successful treatment of a gastric ulcer raises the pulse-rate. When looking through some volumes of records of medical cases, I found that, in the absence of true heart disease, every pulse-rate of less than 60 per minute was associated with gastric trouble. If, however, bronchial spasm were an important etiological factor in the production of massive collapse, asthma should be a common forerunner. But asthma is not a precursor of massive collapse or of pneumonia. On the contrary, it is my experience, and Dr. Haldane and Professor Jonathan Meakins⁵⁸ agree, that asthmatic patients take anaesthetics extremely well, and usually are spared renewal of attacks for at least a week after a general anaesthetic.

I have been asked how massive collapse can predispose to pneumonia, if it is only 'airlessness of the lungs'. In reply, I deny that, in my view, massive collapse is a purely mechanical phenomenon; for there is always pyrexia and increase in pulse-beat and respiratory rate, and usually mucopurulent sputum. To my mind, the most satisfactory explanation which will fit in with observed facts and established theories is as follows:—

Pain in the abdomen from operative trauma, or from inflammation, leads to rigidity of the abdominal wall and to reflex inhibition of the diaphragm, and perhaps to some degree of spasm of the lower intercostal muscles. The lower lobes of the lungs then do not freely expand and contract, so that congestion with some oedema sets in. The bronchioles of the disordered region are more or less choked by this swelling of their walls, which has been increased from irritation by the anaesthetic agent. Into this motionless and well-nourished region, germs and particles of debris arrive, either by the air or by the blood or lymph. In these cases the patient cannot cough freely, and the debris, which should be expectorated or at least evacuated by the ciliated epithelium, lie undisturbed. Closure of the bronchioles and absorption of air from the alveoli now ensues (Elliott and Dingley).

The result of this process is massive collapse of the lung, or, according to Whipple, pneumonitis. When the infection is particularly virulent, the patient's resistance is low, and the diaphragmatic paresis persists. We shall not be surprised to find true bronchopneumonia as the sequel, and it will be of coalescing lobular distribution following the bronchiolar blocking which was the determining factor of the lung collapse.

8. THE PROCESS BY WHICH THE LUNG BECOMES INFECTED.

Effect of Season.—In most years, experience shows that patients run greater risk of lung affection if they undergo operation in the winter months. Låwen found that 70 per cent of his series of post-operative lung infection

occurred in the winter, and Armstrong's results agree with this. Stuart Ross,³⁶ working in Macedonia, recorded 21 cases of post-operative pneumonia; 11 of these occurred between the middle of December and the end of February. Whipple, however, in each of three consecutive years, namely, 1915, 1916, and 1917, observed that March was the month with the heaviest incidence. In 1921, 1922, and 1923, my clinical records and the post-mortem findings show that the end of November and beginning of December, together with the months of February, March, and April, were the worst periods.

At Vienna, in the winter 1919-1920, during the great shortage of coal and food, Mandl's clinic received a heavy visitation of lung trouble, which appeared in 27 per cent of the operation cases. Mandl used digipurat in large doses with satisfactory results, for the incidence dropped to 8 per cent.

The Influence of Country and Town.—At the Anaesthetic Section of the British Medical Association Meeting at Glasgow in 1922, Mr. H. J. Patterson affirmed his belief that operations of choice should be performed in the country. The hospitals in the city should be reserved for urgent cases. In support of this contention Mr. Patterson supplied records of two series of cases, one of 150 operated on in the city, and the other of 150 country operations. The surgeon, anaesthetist, and anaesthetic agent being the same for all the patients, he showed that the average post-operative rise of temperature was one degree higher in the town series than in the country list.

Nevertheless, while agreeing that country air must be less heavily laden with germs, one not infrequently hears of post-operative pneumonia attacking patients in country cottage hospitals.

In the course of this essay, mention has been made of the work in operating centres all over the world. Not one, with knowledge of the facts, can claim to be free from this scourge.

The Effect of Epidemics.—If there be proof of the increased prevalence of post-operative lung complications during epidemics of coughs, colds, and influenza, surgeons will do well at those times to postpone less urgent operations until better conditions prevail. When doctors in general practice are busy with widespread catarrhal troubles, influenza, and pneumonia, I have sometimes noticed simultaneously an outbreak of post-operative pneumonia at the hospital. In February, 1924, colds were raging everywhere, and one morning 3 fresh cases of pneumonia were reported from the surgical wards. In November and December, 1921, during the course of a fortnight, 6 cases of pneumonia occurred after operations, and I was informed later by Dr. Ashley Daly that during the same period at the London Hospital, chest complications had become so frequent that some of the surgeons postponed operations wherever possible.

Gynaecological operations rarely lead to pneumonia (2 cases in 110 patients), but during the season of epidemic catarrh the gynaecological ward at the General Hospital with 12 beds claimed 4 victims to acute bronchitis after operation. All recovered, but, had the operation involved the epigastrium, dangerous pneumonia might have been the sequel.

I expended some considerable time and energy in the preparation of a table to show the incidence of pneumonia in medical and surgical autopsies for each month in the two years, May, 1920, to April, 1922. The numbers

were too small for inclusion here, but in general terms February, March, April (when catarrhal conditions are rife) were the months of highest incidence of secondary pneumonia in the medical and surgical cadavers, and it is interesting to find that in these months there were most autopsies on primary pneumonia.

In my series of 222 operations on the stomach, 24 were complicated by pneumonia. Of these, 11 occurred in February, March, and April.

Attention has already been drawn to the relatively frequent appearance of secondary pneumonia in the surgical wards during the influenzal epidemic of 1918.

The Quality of the Air in the Ward.—At the General Hospital, ventilation is effected by the plenum system. This method produces a still and enervating atmosphere, which is particularly oppressive in the smaller rooms. Many of the staff attribute post-operative pneumonia to this cause, and point out patients who, though seriously ill in a side ward, have quickly recovered when placed on a balcony in the fresh air.

But the post-operative incidence is not more serious at the General Hospital than it is at the Queen's Hospital, where fires and open windows are employed, and I refer the reader to the comparison of the post-mortem findings given in *Table II*. Yet, physicians rightly agree that well-warmed fresh air is essential for the nursing of pneumonia.

The next question is: Is the air from the long and dusty channels of the plenum system laden with pathogenic organisms, such as the pneumococcus or tubercle bacilli? Dr. Hillier and I set out to collect evidence on this point. Asbestos wool was packed lightly into a wide silica tube. This was sterilized in a Bunsen flame and, without touching the wool, the apparatus was placed in a hole in a stiff sheet of cardboard, and the cardboard was fixed in a ward, over the opening of one of the plenum air-inlets. After an interval of from three days to a week, the asbestos wool 'catch' was immersed in broth. Cultures from the emulsion thus formed did not grow any organism of pathological importance. Some of the broth was injected into guinea-pigs and into mice. We performed the experiment three times. The guinea-pigs were not affected, but on two occasions a mouse died. Dr. Hillier found a coliform bacillus in the heart's blood of each of these animals, but no pneumococci, streptococci, or tubercle bacilli were found.

As these investigations were undertaken when coughs, colds, and pneumonia were present in the ward, we decided that the plenum air was safe.

Infection by Aspiration of Material from the Upper Air-passages and the Mouth.—When my attention was first drawn to the subject of this essay by Professor J. Shaw Dunn, then Professor of Pathology in Birmingham University, he said that, in his opinion, aspiration pneumonia was the commonest form of post-operative pneumonia, and was identified at post-mortem by the presence of multiple suppurative foci in the lung. Låwen records 180 cases of pneumonia in a series of 9755 operations. Of these cases, 40 were due to aspiration of material into the lung. Certainly, until the introduction of intratracheal methods, aspiration pneumonia was chiefly responsible for the high death-rate after operations for excision of cancerous growths in the mouth, pharynx, nose, or larynx.

Many authors agree with these views. Von Grossman⁸⁷ suggested that,

during an attack of rhinitis, ether vapour 'skinned off' infected material from the nose, and this was aspirated into the lung. Darnall⁶² thought microbes from infected air-sinuses might lead to the trouble. Cutler and Morton blamed inhalation of nasal mucus and pus from septic teeth and gums. Wight considered that atropine, by drying up the nasal and oral secretions, reduced the danger to the patient.

The hypothesis is employed to account for many of the points observed. Beckman¹³ thus explained the almost invariable lobular distribution, and Schultze⁵ on anatomical grounds, said aspiration would lead more readily to infection of the right lung (the usual sufferer). By experiments on animals, Cooper⁸⁹ showed that dry soot placed in the larynx reached the bronchioles, but not the alveoli. On the other hand, coloured fluids (indian ink) inhaled in the horizontal position entered the alveoli of the upper lobes, but if the animal were placed vertically the lower lobes were filled with the liquid.

During anæsthesia, when inserting the intratracheal catheter by direct laryngoscopy, I have seen mucus drawn into the larynx. If the mucus be heavily infected with pathogenic organisms, one would certainly expect lung trouble to follow. Nevertheless, recently, I saw foul-smelling pus from a large peri-œsophageal abscess enter the trachea. Although this was followed by intratracheal anæsthesia, lasting one hour, the patient did not develop so much as a cough. The abscess had been exuding pus into the œsophagus during several weeks prior to the operation, and the patient's immunity must have been very high.

The ciliated epithelium of the trachea and bronchi normally evacuate foreign particles, but profound anæsthesia of long duration, involving chilling of the mucous surface, together with the action of strong ether or chloroform vapour, must paralyse the cilia. Dr. Flemming has shown that chloroform or ether arrests the cilia of *Paramœcium* provided the concentration be sufficiently great. The action is more easily reversible with ether than with chloroform.

Coughing is Nature's safeguard against foreign bodies in the lung, and, as we have seen, operations, particularly on the upper abdomen, abrogate this function.

To minimize these dangers the author⁹⁰ has designed a special anæsthetic apparatus. It consists of a large oral airway, a funnel-shaped mask, and a gauze carrier. The airway ensures that all air inhaled by the patient shall pass through it. By boiling the apparatus before use, by inserting the airway as soon as the pharyngeal cough reflex is abolished, and by leaving it in the mouth until coughing returns, there is but little danger of aspiration. I have seen pneumonia after anæsthesia induced with this apparatus, but I am confident that aspiration troubles have been less frequent.

Air-borne Infection.—Allusion has been made to small epidemics of coughs, colds, bronchitis, and even pneumonia, which occur from time to time in the surgical wards, and these occurrences seem to prove that neighbouring cases, before or just after operation, may be the source of infection.

Whipple's researches teach us that in many patients, before operation, the pharynx contains pneumococcus *Group IV*, and if pneumonia develops, the sputum gives a culture of the same organism. Thus, without the aspiration

of mucus, patients' lungs may be infected by the organisms present in their own throats, if the protective power of the lung is lost.

Infection from the Lymph.—Läwen said that 8.5 per cent of his patients who suffered from peritonitis developed pneumonia. This high incidence he attributed to the flow of infected lymph from the peritoneal cavity through the right half of the diaphragm to the pleura and lung. This suggestion may explain the relative frequency of right-sided pneumonia in these cases, there being no direct passage for the lymph through the left half of the diaphragm. Goebel goes further, and suggests that, when opening the stomach or bowel during gastro-enterostomy, the chyle is infected by the intestinal contents, and direct flow through to the lungs is effected. But the interior of the intestine hereabouts is nearly sterile, and it is not easy to see how the chyle gets directly to the lungs.

In my opinion, lymph infection from the abdomen gives rise to pleurisy rather than to pneumonia, and the post-mortem records support this view. Empyema occasionally follows operations on an infected gall-bladder, and pneumonia in these cases is usually absent. A colleague suffering from a right-sided metastatic subphrenic abscess developed serofibrinous pleurisy without pneumonia. In the course of six months three patients, of whom one died, each showed right-sided pleurisy without pneumonia complicating convalescence from gastro-enterostomy.

Infection from the Blood-stream.—The blood may promote infection of the lung by one of three methods.

a. In septicæmia, blood laden with organisms deposits its load in the lungs. Rogers⁸⁸ investigated the bactericidal power of the normal lungs of dogs and rabbits. By injecting *B. anthracis*, or *Staphylococcus aureus*, or *Streptococcus erysipellatus* into the external jugular vein, and into the portal vein, he found that the lung destroyed these germs, but not so speedily as the liver. It is reasonable to deduce that the lung of an enfeebled, semi-narcotized patient has lost some of this bactericidal power.

b. Septic embolism. These emboli may be minute, but it is a common event in the post-mortem room to find in the cadavers of patients who have suffered from septic mastoiditis, suppurative peritonitis, or widespread cellulitis, numerous small abscesses scattered through the lungs, sometimes, but not always, surrounded by areas of consolidation. True infarction may occur.

Cutler and Morton stated that 60 per cent of their cases of pneumonia showed a septic focus, and they, together with Hunt, believe septic embolism to be the primary causal factor for which we are seeking.

For my part, on examination of post-mortem records, I have been surprised by the frequent occurrence of abscesses in the lung in fatal mastoid disease—probably through the spacious lateral sinus and the jugular vein. In two years, in 1000 post-mortem examinations there were 21 examples of septic emboli in the lungs.

c. Non-infected pulmonary embolism. There can be no doubt that many conditions diagnosed as collapse of the lungs, or as pneumonia, are examples of pulmonary embolism. The sudden attack of severe pain, the motionless ribs over the affected area, and the stony dullness, sometimes misguide the observer, who may diagnose massive collapse of the lung.

It is by no means a rare catastrophe. At the General Hospital fatal aseptic pulmonary embolism occurred 9 times in a series of 8000 operations of all kinds (0·11 per cent). This does not include those who died after leaving hospital. In Korte's⁹¹ clinic at Berlin, 22 cases of pulmonary embolism were recorded in 9727 operations (0·2 per cent). Rauzi's figures are 57 in 6871 operations (0·83 per cent).

Within one week three patients whom I had anaesthetized died of the condition. The operations were for the removal of gall-stones, of a carcinoma of the breast, and of the prostate, respectively. The accidents occurred at least two weeks after operation. In the great majority of cases the accident follows operations on the pelvic organs, namely, uterus, prostate, and even hæmorrhoids (as in an old lady recently).

Lockhart-Mummery⁹² and Sir Thomas Lewis blame slow circulation due to : (a) A weak heart, as in the aged ; (b) Operations among the large veins of the pelvis ; and (c) Loss of fluids. Laphorne-Smith⁹³ states that there is excess of fibrinogen in the blood, and he recommends that great care should be taken to replace loss of fluid from perspiring, vomiting, catharsis, diuresis, and hæmorrhage. Free movements should be started as soon as possible, and digitalis will help to promote a strong heart-beat.

Should the patient rally from the primary attack, abscess of the lung, or pneumonia, which Beckman considers to be lobar in type, may follow.

CONCLUSIONS.

As briefly as possible, I now append the conclusions to which this lengthy discussion has led me :—

1. Post-operative pneumonia occurs with grave frequency.
2. Often it is not recognized, and figures which purport to give its incidence are unreliable.
3. The anæsthetic agent and the method of administration, save in special cases, seldom are decisive factors.
4. Age and sex are not of importance.
5. General health and local disease of the lungs may play a considerable part.
6. At operation, every care should be taken to prevent loss of heat, of fluid, and of blood, and especially exhaustion from trauma to nerve tissue, and to highly vascular parts.
7. Infection of the lung is often by means of aspiration in the presence of certain other factors.
8. Severe sepsis in other regions affects the lung via the blood-stream.
9. There is evidence that lymphatic infection through the right half of the diaphragm leads first to pleurisy and then to pneumonia.
10. In the absence of severe sepsis, operations on the abdomen, and especially the upper abdomen, provide the start of the chain of events which leads to pneumonia.
11. Pain in the abdomen from operative trauma, or from inflammation, gives rise to rigidity of the anterior abdominal wall and to reflex inhibition of the diaphragm, together with some spasm of the lower intercostal muscles.

The lower lobes of the lungs, then, do not freely expand and contract, so that congestion of blood with œdema sets in. The bronchioles of the disordered region are more or less choked by this swelling of their walls, which has, perhaps, been increased from irritation by the anæsthetic agent. Into this motionless and well-nourished region, germs and particles of débris arrive. The mode of access may be by the air or by the blood or by the lymph. In these circumstances the patient cannot cough owing to pain, and the exudate and the débris, which should have been expectorated or evacuated by the ciliated epithelium, lie undisturbed in the lower lobes. Closure of the bronchioles in this nearly motionless area, and absorption of air from the alveoli, now ensue (Elliott and Dingley). The result of the process is massive collapse of the lung or, according to Whipple, pneumonitis.

When the infection is particularly virulent, if the patient's resistance is low, and if the diaphragmatic paralysis persists, we shall not be surprised to find true bronchopneumonia as the sequel, and it will be of coalescing lobular distribution, chiefly in the lower lobes, affecting those lobules whose obstruction determined the collapse of that portion of the lung.

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SPONDYLITIS DEFORMANS.

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THIS is the name given to a complex group of cases which possess in common certain characteristic clinical features—namely, a painful stiffness of the spine ending in its complete rigidity, combined, in nearly all instances, with a kyphotic curvature producing a variable degree of deformity. Museum specimens obtained from such cases are usually macerated, and often, owing probably to the very chronic course of the malady, without clinical notes. Consequently their classification presents difficulties; yet by the study of the pathological anatomy it is possible to resolve these heterogeneous cases into at least three separate pathological conditions, each of which has its own peculiar clinical characters. These pathological and clinical peculiarities point to the recognition of three different affections:—

I. *Ossification of the spinal ligaments, more or less general*, is the characteristic lesion in one set. This condition may be designated *spondylitis ossificans ligamentosa*.

II. *An upper dorsal curvature and atrophy of the vertebral discs* distinguish another set. As this condition depends in the first instance upon impaired muscular power, it may be called *spondylitis muscularis*.

III. In a third set the *changes are of an osteo-arthritic nature*—*spondylitis osteo-arthritis*.

I. OSSIFICATION OF THE SPINAL LIGAMENTS.*(Spondylitis Ossificans Ligamentosa.)*

Ossification of ligaments is the conspicuous abnormality in a very large proportion of museum specimens of spondylitis deformans. This preponderance is probably accidental, and may depend upon the striking character of the lesion.

Every gradation may be met with, from ossification of the anterior common ligament alone, to a similar change in all the spinal ligaments. Often when the spine is affected, other joints—such as those of the limbs, the shoulder girdle, and the jaw—are attacked. But the disease in the spine is peculiar to it; ankylosis there is due to this ligamentous ossification. In the other joints the ligaments do not ossify, but opposing articular surfaces become united by fibrous tissue, and eventually by bone. There are, however, certain joints in the spine which ankylose in the same way—namely, the occipito-atloid and the atlo-axoid—but in these movement is free, and there is no intervening fibrocartilage.

The condition which occurs in the joints of the extremities in association with spondylitis ossificans ligamentosa is that which, at the present time, is regarded as rheumatoid arthritis, and there cannot be much doubt that the affection which is being considered here is the form that disease assumes

when it attacks the vertebral column. The pathogenesis is also similar, the manifestations in both cases being almost certainly the result of circulating toxins. Pathologists of a bygone generation were on the right tack when they began to associate these painful rigid spines with the after-effects of gonorrhœa, but in these days it seems astonishing that they should have suspected a problematical gonorrhœa when they were in the presence of a suppurating condition of a different kind.

OSSIFICATION OF THE ANTERIOR COMMON LIGAMENT.

This may occasionally occur by itself in the human subject (St. Bart.'s Hosp. Museum 1080A), but it is usually associated with ossification of other spinal ligaments.

The ossified ligament may form a strip of bone attached along the front of a number of consecutive vertebræ, as in the spine of a celebrated Parisian character called Seraphin, which is illustrated in Hutchinson's *Archives* (vii, 246, Pl. cxxxiii; also in the Catalogue and Atlas of the Musée Dupuytren, 652A, where it is described at greater length), or may even extend the whole length of the column. But the ossific layer shows a tendency to spread laterally over one or both sides of the bodies, and in advanced cases round to the back. The posterior common ligament may also be involved. This was so in Seraphin's spine, and also in that of an old woman who had been bedridden for twenty-five years and died of intestinal obstruction. In her case every joint in her body was affected, including the temporomandibular and sterno-clavicular (St. Bart.'s Hosp. Museum, No. 1085c).

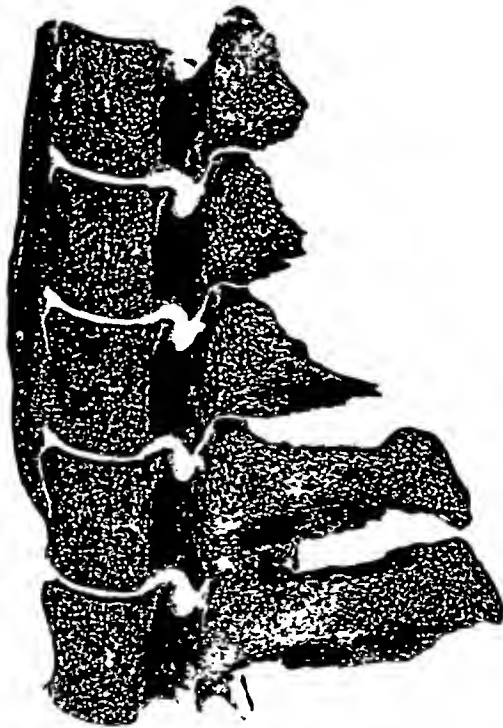


FIG. 306.—Dorsal vertebrae of a horse showing ossification of the anterior common ligament (No. 2054, R.C.S. Museum).

The tendency for the ossified layer to cover both the front and sides of the bodies may be explained by the variations met with in the anterior common ligament. It is by no means invariably a well-defined ligamentous strip over the most prominent part of the curve of the bodies, but it may cover more or

less completely their whole anterior surface. Less dense at the sides than in front, it is apt to show small elongated gaps, the ligamentous tissue being insufficient to make a complete covering (see description in Morris's *Anatomy of the Joints*, 72, and Quain, iv, Pt. 1, 223). A definite bulging over the position of the discs occurs in the healthy spine, but in these cases it is apt to be exaggerated, not as a consequence of osteophytic lipping for which it is very commonly mistaken, but because atrophy and consequent recession of the naturally concave surface of the bodies allow the edges of the discs covered by the bony layer to form prominent projections (Birmingham



FIG. 307.—Exuberant ossification of the anterior common ligament over the cervical and upper dorsal vertebrae of a lion. Front view (No. 2456, R.C.S. Museum).



FIG. 308.—Lateral view of the same specimen as shown in Fig. 307.

University Pathological Museum, No. 93 (0.47) 85.2a and 2b). There is no alteration of the articular surfaces of the bodies, which are sharply demarcated from the new osseous layer.

Among the ancient Nubian bones in the R.C.S. Museum are several specimens illustrating degrees of spondylitis ossificans ligamentosa. In No. 205 ossification is limited almost entirely to the anterior common ligament over several dorsal vertebrae. In No. 206 ossification extends on to the right lateral surface of the vertebrae, and the laminae also are fused. In another

(also labelled 205, and much battered) ossification involves the front and lateral surfaces of the bodies, and there is bony ankylosis of the articular processes and ossification of the supraspinous ligament.

Ossification of the anterior common ligament is obviously only a stage, and probably an early one, in a morbid process which is prone to involve other ligaments and to merge into the pronounced form of the disease. But even in the well-marked affection, curiously, it may be completely absent (*see Cases 2 and 3*). It is, however, quite common in certain animals—more particularly in horses and asses. The following account of it is given in Yonatt and Watson's book on the horse (4th ed., 249):—

“If the horse be much overweighted, or violently exercised or suddenly pulled upon its haunches, these ligaments are strained. Inflammation follows. The ligaments are changed into bone, and the joints of the back lose their springiness and ease of motion—or rather, in point of fact, they cease to exist.

“On account of the too hard service required from them, and especially before they have gained their full strength, there are few old horses who have not some of the bones of the back or loins ankylosed. When this exists to any considerable extent the horse is not pleasant to ride; he turns with difficulty in his stall, finds it hard, when down, to rise again, and he has a singular straddling action.”

Several specimens in the R.C.S. Museum (Nos. 2053, 2054, 2055) illustrate this condition. (*Figs. 306, 307, 308.*)

Another remarkable appearance is seen on sagittal section of these specimens, whether human or equine—namely, the spaces left between the ankylosed vertebræ by the removal of the intervertebral substances during maceration. They may be almost linear, suggestive of atrophic fibrocartilages, but more commonly they appear to have been occupied by discs of normal thickness. Occasionally, too, there are signs of ossification having taken place in the disc itself. This occurs at first in the peripheral parts of it, but it may be more extensive in advanced disease, when the space may be partially obliterated by new bony deposit.

GENERALIZED OSSIFICATION OF THE VERTEBRAL LIGAMENTS.

Morbid Anatomy.—The ligaments usually affected are the anterior common ligament, the posterior common ligament (much less frequently), the ligamenta subflava, the capsular ligaments of the articular processes, the ligaments connecting the ribs with the vertebræ, and the supra- and interspinous ligaments. When the neck is involved, the atlas-axoid and the occipito-atloid articulations may be ankylosed, but the evidence of ligamentous ossification is not so definite here as elsewhere. In well-marked cases the vertebral bodies are overlaid in front and on both sides, and sometimes even behind, by an evenly disposed layer of bone which bridges and conceals the discs. It may extend over a number of bodies, and in some cases from the base of the skull to the front of the sacrum. Its uniformity may be such that its connection with the anterior common ligament might almost be doubted. (*Figs. 309 and 322.*)

A sagittal section through such a macerated spine (*Figs. 310 and 311*) shows the superficial disposition of the new bone, and the regular array of intervertebral spaces from which normal-sized discs have been removed. The appearance of the section comes as a surprise, for before division the spine looks like a solid bony cylinder. The discs evidently had been preserved from pressure by the fixation of the vertebræ, and were probably healthy. Ankylosis of the articular processes and of the ribs with the vertebræ is partly



FIG. 309.—Spondylitis ossificans ligamentosa—the generalized form. The plate shows the moniliform thickening corresponding to the vertebral discs, and the atrophic recession of the bodies between the prominences (*No. 2109, R.C.S. Museum*).



FIG. 310.—Sagittal section of the spine shown in *Fig. 309*. Note the ossified anterior common ligament, the spaces left by the removal of the discs, and the fusion at the bases of many spines. The groove running down the centre of the bodies is an artefact.

due to the bony change in the ligaments and partly to arthritis, for if a suitable section be made, the joint cavities are seen to be either partially or completely obliterated and the cancellous tissue of the two bones to be continuous (*Fig. 312*). On the other hand, bony union of the articular surfaces of the bodies is delayed, because the discs persist long after vertebral ankylosis has taken place. When it does occur it is due to ossification of the intervertebral substance advancing from the periphery.

This method of invasion of the disc, though a small point, may be added to other facts which tend to show an affinity between spondylitis ossificans ligamentosa and rheumatoid arthritis. The others are: the occurrence in many cases of rheumatoid arthritis in the joints of the extremities, and the frequent presence of an infective focus prior to the onset of the disease.

Mention must not be omitted of those rugosities, tubercles, and stalactitic processes which are often present on the osseous surfaces in the neighbourhood of the joint changes and are obviously abnormal. They may be associated with the attachments of the interspinous and supraspinous ligaments, and as they advance lead to complete ossification of those ligaments. They are also in evidence along the iliac crests and on the front of the pubic bodies and the pubic and ischiatic rami, and in these situations they suggest a connection with the attachment and action of the various muscles. (Fig. 313.)

Pathogenesis.—In the pathogenesis of the generalized affection the toxic factor is probably supreme, but in



FIG. 311.—The 3rd, 4th, and 5th lumbar vertebrae of the spine shown in Figs. 309 and 310, on a larger scale.



FIG. 312.—Transverse section through the articulation of the 1st rib with the vertebra, showing bony ankylosis. From the same spine as that shown in Figs. 309, 310, and 311.

ossification of the anterior common ligament alone, traumatism, in the form of ligamentous strain, is probably more important than toxins.

In this connection, where horses are concerned, it must not be overlooked that pyorrhœa is of frequent occurrence owing to the impaction of particles of food (hay, oats, etc.) between the alveolar border and the gums.

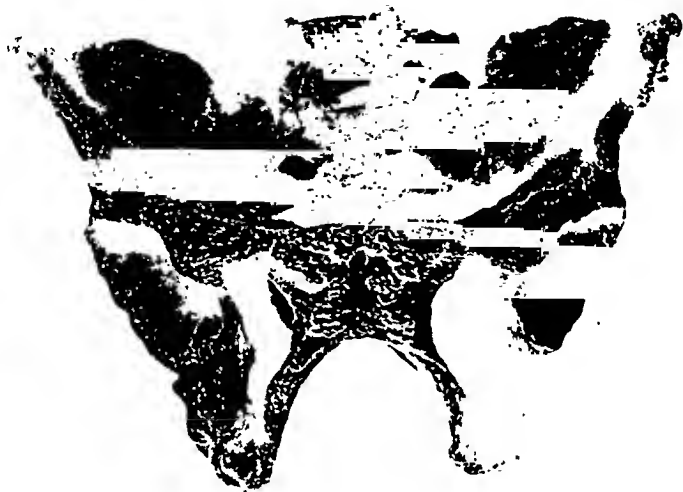


FIG. 313.—Pelvis showing spondylitis ossificans ligamentosa involving the lumbosacral joint. The sacro-iliac synchondrosis and the symphysis pubis are ankylosed. Note the rough osseous nodules in front of the pubic bodies, along the sides of the pubic arch, and at the anterior superior spines (No. 4585, *Guy's Hospital Museum*).

CLINICAL VARIETIES.

The clinical picture of the generalized form of spondylitis ossificans ligamentosa is sufficiently distinctive. The variations depend upon the extent to which the vertebral column is invaded, and the way in which the joints of the extremities suffer.

Considerable attention has been devoted to certain cases in which the proximal joints (root joints) of the extremities have shared the ankylosing affection of the spine. They are often alluded to as the Marie-Strümpell type, and Pierre Marie, who suggested the name 'rhizomelic spondylitis', defined the condition as "extremely pronounced rigidity of the spine and ankylosis of the hip- and shoulder-joints". The case described by Strümpell¹ was the following :—

*Case 1 (Fig. 314).—*In a fisherman, age 39, the disease had begun without warning three and a half years previously with pains in the loins, right hip, and thigh. The loin pain sometimes radiated to the stomach region. The pains were never very violent or long-continued, and the stiffness in the loins was more troublesome than the pain. The movements of the head, cervical spine, and upper extremities were normal. The lower dorsal and lumbar spine was rigid and remained like a rod in bending and lateral movements. The upper part of the body was bent forward in standing and walking. The dorsal muscles were atrophic and strangely firm and solid, and the hip-joints were fixed in slight flexion. Under anaesthesia there was no relaxation of the spinal rigidity, and limitation of movement and crepitation were present in the right hip.

He had previously described a more advanced case in his *Lehrbuch*,² and had emphasized the progressive course of the disease which "without pain ends in complete ankylosis of the spine and hips, so that the head, trunk, and femurs are firmly fixed to one another and are completely rigid, while all the other joints retain normal mobility", and a quite peculiar modification of the attitude and gait results.

An exhaustive paper on this condition was published by Léri, who was associated with Marie. He referred to the case recorded by Hilton Fagge³ as the best example of rhizomelic spondylitis that he had met with. The following description of a specimen from that case and the history are taken from the Guy's Hospital Museum Catalogue (No. 4450).

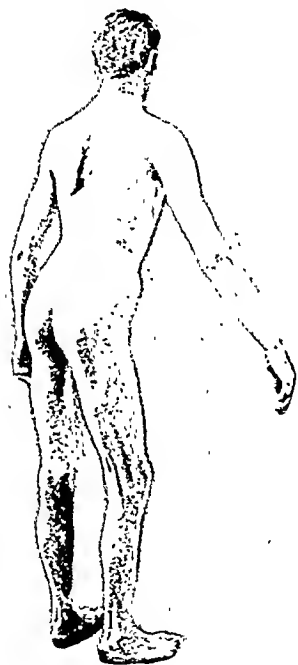


FIG. 314.—Case 1. Spondylitis ossificans ligamentosa. Strümpell's case of rhizomelic spondylitis.

Case 2.—George B., age 34, admitted under Dr. Wilks for bronchiectasis, from which he died. He had been a wire worker, and said that although his chest was never well-formed he had always had good health until four years before admission. He then complained of pain in the abdomen, constipation, and loss of appetite. A year ago he began to stoop a great deal, and the abdominal pain returned, so that he was obliged to give up work. At the time he developed a severe cough, and brought up large quantities of sputum. On admission he was unable to walk without assistance, his spine was much bowed, and was completely fixed in the dorsal and lumbar regions, and only capable of a slight degree of movement in the cervical region; his chest was flattened at the sides, and so great was the degree of kyphosis that the abdomen as low as the umbilicus was in contact with the skin covering the lower part of the thorax. At the post-mortem the bronchi of both lungs were found to be widely dilated, but the alveoli appeared to be healthy. There was no sign of tuberculous disease. The heart was hypertrophied, and the great vessels were atheromatous.

The Specimen.—The vertebrae are ankylosed by deposits of bone between the articular processes, laminae, and spinous processes, and to one of them a portion of rib is similarly united. (Fagge states that the ribs generally were ankylosed to the vertebrae, and on section of one of them there was perfect continuity of one bone with the other.) There is noipping of the bodies as commonly seen in osteo-arthritis. Their substance is soft (they could be cut with a knife), and both the cancellous tissue and its compact covering have undergone much rarefaction. The hip-joint is the seat of fibrous ankylosis. The line of the articulation as seen on section is natural, and the head of the femur has preserved its normal contour except at its margins, where some erosion has taken place. (Fig. 315.)

There are very few post-mortem records of cases of spondylitis deformans, but in the following case of Léri's⁴ we have fortunately a second instance of a good clinical history, with the report of the subsequent examination of the spine.

Case 3.—A cook (*Cog*), age 39, was completely cured of a gonorrhœa in 1877. In 1888 he had an acute illness diagnosed as 'acute rheumatism with purpura', and shortly after his recovery, and following some fugitive joint pains, he experienced severe pain in the loins and sacrum, with noises at the top of the sacrum and in the hip. A long rheumatic and varying illness followed, and in 1890 the spine was found immobile. In 1891 the neck became fixed, and the shoulders were attacked. In 1898 his condition was as follows. The cervical spine formed an angle of 140° with the trunk; the chin was close to the sternum; the lower limbs were straight, but flexed at the hips at an angle of 125° . The spine, head, hips, and knees were absolutely rigid, and the movements of the ankles and toes were somewhat affected. Those of the shoulders and lower jaw were impaired, and crepitation was present in the shoulder-joints. The thorax was flattened antero-posteriorly and the abdomen voluminous and spread out. There was no sign of nerve trouble. The patient lay in a half-sitting position, with legs extended, and the upper part of his back and head resting against heaped-up pillows. If his legs were vertical, his head projected a yard in front and caused him to fall. Léri compared his body to a sea-saw with the fulcrum at the hips. If his back lay on the bed, his legs went up in the air.

Examination of the spine after death showed that there was no ossification on the front of the vertebræ: both anterior and posterior common ligaments were unaffected. Ankylosis had occurred between the anterior portions of the lumbar vertebræ for a depth of 2 to 5 mm. between the bodies, beyond which the discs preserved their ordinary bi-convex shape, and showed no diminution of thickness. The posterior part of the disc between the 6th and 7th dorsal vertebræ was ossified and united the two bodies. The occiput was united to both lateral masses of the atlas, the anterior arch of the atlas to the odontoid process of the axis, and the lateral masses of the atlas to the articular processes of the axis. The posterior arch of the atlas was wanting.

The articular processes were absolutely ankylosed the whole length of the column. Many laminae were united from ossification of the

ligamenta subflava. The spinous processes were nowhere completely ankylosed. The ribs were ankylosed to the vertebræ by almost all their ligaments, at both costovertebral and costotransverse articulations, and at the latter the two bones fused. The intervertebral foramina were only slightly narrowed, and the soft parts there and in the canal were quite normal and raised no suspicion of inflammation.

Pain and ankylosis are the special features of spondylitis ossificans ligamentosa. The one seems to be the precursor of the other. In the rhizomelic form the pain is apt to be located in the lumbar and sacrococcygeal regions or in the hips. It may occasionally be altogether absent, but in most cases it is continuous, and aggravated by certain positions or on movement. Its onset is sometimes sudden, and may be so violent as to be agonizing. Long-continued fixed pain in the loins or sacral region is very suggestive.



FIG. 315.—*Case 2.* Four vertebræ and a hip-joint from Hilton Fagge's case (No. 4450, Guy's Hospital Museum).

The diagnostic sign is ankylosis. As a rule, it extends from below upwards, involving the lumbar, dorsal, and cervical spine in this order. In the lumbar region it is preceded by a painful period which disappears as ankylosis takes place. There is said to be marked freedom from pain when the dorsal region is attacked, contrasting with the pain which ushers in ankylosis in the lumbar region, and at a later date in the cervical spine. It has been attributed to the normal want of mobility in the dorsal spine. Though extension to the cervical region may be steadily progressive, there is often a considerable interval—even a year or more—before that part of the spine is attacked. Its implication is marked by pains in the neck. The hips become involved when the disease is active in the lumbar region; the shoulder, sternoclavicular, and temporomandibular joints are in danger when the cervical and upper dorsal spine is attacked; and ankylosis of the ribs to the vertebrae probably synchronizes with dorsal mischief; but this condition can only be recognized by the respiration becoming entirely abdominal. Léri allows a certain elasticity to the original conception of rhizomelic spondylitis by admitting that the peripheral joints of both upper and lower extremities may exceptionally be invaded, and that ankylosis in the shoulder-joints is probably uncommon.

There is no rule as to the deformity produced by rhizomelic spondylitis (*Figs. 314, 316*). The spine may be greatly curved or remain extended, or, as Léri puts it, 'less flexed'. The lumbar curve is apt to be obliterated, and a forward bend to develop in the upper dorsal region, so that, with the hips ankylosed in flexion, the trunk takes the form of an arc. Probably the deformity is in part determined by an attitude assumed for ease—only so can we explain why in some cases the head is flexed on the spine, and in others ankylosed in complete extension (*Fig. 317*). But kyphosis is likely to develop when rarefaction and softening of the vertebral bodies is pronounced (*cf. Case 2*).

So far the description of the generalized form of spondylitis ossificans ligamentosa has been concerned with the type known as rhizomelic. There are, however, other cases in which the disease is so widespread that practically all the joints of the body become ankylosed. Sir Jonathan Hutchinson⁵ has described one in his *Archives*.

Case 4.—The patient, a rather florid man, age 54, had suffered for twenty years, and was almost literally one piece of bone. Knees, ankles, and hips were quite stiff, and so were his elbows, shoulders, and wrists. The last-named joints were still somewhat swollen, and not absolutely ankylosed. His hands and feet were distorted, and all his digits bent into the palm. His hands lay on his chest, and he could not



FIG. 316.—One of P. Marie's cases showing the bent ankylosed position in rhizomelic spondylitis (*Rev. de méd.*, 1898, xviii, 290).

lift them. His lower jaw was ankylosed, but he could still eat when food was put into his mouth. He attributed his attack to having been put in a damp bed. He had never had acute rheumatism, and his symptoms had developed very gradually. For a long time he helped himself about with sticks; then for six years he went about on crutches; then for eight in a bath chair; and finally for seven he had been bed-ridden in Lambeth Infirmary. He said that he was never free from aching pain. He had been for many years the subject of stricture and had had gonorrhœa before the rheumatism set in. . . . The whole of the spinal column with the exception of the neck appeared to be stiff.

The following very similar instance came under my own observation.

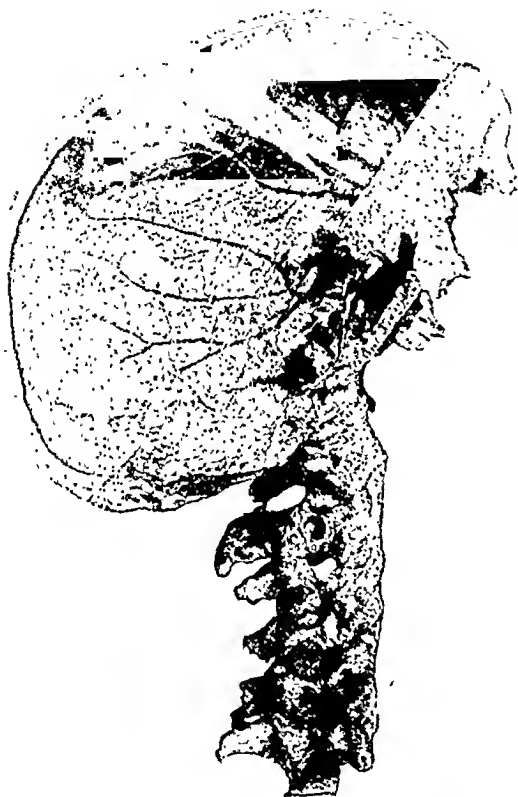


FIG. 317.—Spondylitis ossificans ligamentosa showing the skull ankylosed in complete extension (No. 93.852, Manchester University Pathological Museum).

Case 5.—A gentleman, age 37, was the subject of an ankylosis so general and so complete that he could only produce a little movement in two or three toes, and twitch one shoulder slightly. His spine was quite rigid, but his temporo-mandibular joints remained free.

The illness began with painless effusion into both knee-joints just when a subacute gonorrhœa had apparently recovered. The disease ran a rapid course and in three years reduced him to the state I have described. It did not seem to have been attended with much pain, but he had become blind in both eyes from the effects of iritis. Some time before he contracted the gonorrhœa he had suffered from pleuritic effusion, and his knee-joints had filled with fluid during his convalescence; from this illness he had made a satisfactory recovery.

There can be no doubt of the close relation of these cases to gonorrhœa, and that the completeness of the ankylosis gave rise to a remarkable clinical picture. It is unfortunate that no record of the morbid anatomy of similar cases could be found to compare with that of rhizomelic spondylitis described in

Cases 2 and 3. But two points about those cases may be impressed: (1) There was no ossification along the front of the vertebral bodies—a fact which is remarkable when we remember the frequency with which such ossification is present in museum specimens; and (2) There was no associated gonorrhœa in *Case 2* and one of no significance probably in *Case 3*.

It may be that, as knowledge accumulates, a definite form of spondylitis ossificans ligamentosa will be found to be associated with gonorrhœa as clearly

as Chareot's joint disease is with syphilis, but at the present time this cannot be shown.*

II. CASES CHARACTERIZED BY AN UPPER DORSAL CURVE AND ATROPHY OF THE INTERVERTEBRAL SUBSTANCES.

(*Spondylitis Muscularis.*)

CLINICAL FEATURES.

In this condition the mischief is usually limited to the upper part of the spine, and the joints of the extremities are not involved. Slight degrees of it are familiar to all of us in hump-backed and round-shouldered people; but the more pronounced stages are uncommon, and it is to them that the term *spondylitis deformans* is more particularly applied.

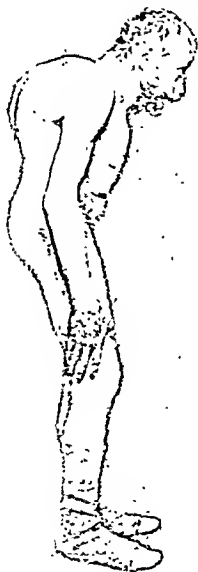


FIG. 318.—Case 6. *Spondylitis muscularis*. The patient in Marie and Astie's case—'cyphose hérédito-traumatique'.



FIG. 319.—The sister of the patient shown in Fig. 318.

Through the kindness of Mr. H. E. Powell.

In many instances the foundation of the mischief is laid in early life, and after a quiescent period of many years the disease may become aggravated or relapse as a consequence of various untoward circumstances. In well-recorded instances the presence of a stoop dating back as long as the patient was able to remember is often mentioned. The most important element in its causation

A good clinical case is recorded by M. Paul Claisse, *Bull. Soc. méd. Hôp. de Paris*, 1904, xxi, 3s., 1227.

is the *feeble tone of the muscles*, which forces itself upon the attention more particularly in those which normally maintain the erect position of the upper spine and the balance of the head.

Only slightly less material are the *atrophic changes that occur in the intervertebral discs*. These, however, are secondary to the muscular failure, and are caused by the increase of pressure at certain points consequent upon the forward bending of the spine. Other predisposing factors that may be referred to here are *trauma* and *heredity*. The determination of the slighter degrees of upper dorsal kyphosis is often ascribed to injury, occasionally on good grounds; but in many cases of the graver sort a very definite association with injury exists. Sometimes—as P. Marie and Astie⁶ have pointed out—a history of curvature in other members of a family can be obtained, and they distinguished cases in which hereditary tendency was combined with undoubted traumatism by the title ‘*cyphose hérédo-traumatique*’. The case published by them is as follows:—

Case 6.—A man, age 53, who, some days after a fall on his back in which the spine had impinged on a metal utensil he had been carrying, experienced violent pain, a sensation of extreme weight, and—a peculiarly interesting fact—a considerable bending of the vertebral column forwards. He came of a family in which there was a tendency to curvature. His father was bent. His sister, also, notably so. He himself was bent before the accident, but the extraordinary kyphosis actually present developed in the first week following the injury. Careful inquiries were made from the patient and relatives, and there could be no doubt of the direct relation between the actual kyphosis and the trauma. The photographs of the patient and his sister (*Figs. 318, 319*) published with Marie and Astie’s paper show very similar pronounced upper dorsal curvatures.

A similar hereditary factor was present in the following instance on the maternal side.

Case 7.—This case was that of a gentleman, age 73, in whom a severe upper kyphotic curve began to develop in boyhood, after a fall down a flight of stairs in which he hurt his back and broke a clavicle. Stationary for the greater part of his life, it increased so rapidly with failing health that his height diminished 7 inches in a few years. The deterioration in his general condition was initiated by a severe and progressive arteriosclerosis. (Personal observation.)*

The explanation of the sudden increase of the curvature in *Case 6* is probably compression and collapse of the rarefied cancellous tissue of the bodies, whilst that of the gradual loss of height in *Case 7* may be based partly upon compression of rarefied bone and partly on accelerated atrophy of the discs.

The subjects of spondylitis muscularis are usually conscious of a feeling of weakness in the back and of aching pain in the region of the curvature, especially after exercise. In some cases complaint is made of pain in the area of distribution of the spinal nerves involved. This has been suspected

* Messrs. Danlos, Apert, and Levy Frankel⁷ recorded a remarkable instance of a familial tendency to pronounced upper dorsal kyphosis appearing in all its subjects between 5 and 7 years of age. It was associated in one instance with some degree of acromegalic gigantism, and in others with prominent jaws and tall stature. The probability of a traumatic factor was absent in most of them. The possibility of the curvature being a pituitary stigma was considered, but the evidence in support of it was not convincing.

to depend upon compression of the nerve-roots in their passage through the intervertebral foramina, but in the very few observations that have been made this has not been found. Garrod⁸ is of opinion that these nerve-root symptoms "deserve a more prominent place in the symptomatology of the disease* than is usually given in published descriptions", and states that patients in ignorance of their rigid spines will sometimes apply for the relief of radiating pains, which may be of a very distressing character.

Upper spinal kyphosis associated with nerve-root symptoms has been carefully studied by Von Bechterew,⁹ of Petrograd. In a series of papers he recorded a number of cases in which, in addition to rigidity and a kyphotic bend 'above the mammary region', symptoms were present indicative of degenerative changes in the corresponding nerve-roots. These symptoms included: (1) A paretic condition of the muscles of the trunk, neck, and extremities, with slight atrophy of the back and scapular muscles; (2) A diminished sensibility, chiefly in the cutaneous branches of the dorsal and lower cervical nerves, and sometimes of the lumbar nerves, with other variable objective and subjective symptoms; (3) In some cases evidence of motor-nerve irritation, such as twitching, contracture, etc.

Unfortunately he was unable to check his observations by post-mortem evidence until 1899, when a case he had already recorded¹⁰ died of basal pneumonia, and provided the following pathological results:—

An upper dorsal kyphotic curve was present without compensatory lordosis in the lumbar region. The curve was absolutely immobile, and the bodies of the vertebrae forming it were fused anteriorly; the intervertebral discs were either atrophic or had completely disappeared. Elsewhere the discs were normal and the mobility of the lower dorsal and lumbar regions was only slightly restricted. Illustrations show that the kyphosis was not severe and that the various vertebral ligaments were not ossified.

The examination of the nervous system showed the cranial dura and pia to be hyperæmic; the cervical spinal dura to be rather thickened but everywhere smooth. Where the roots had penetrated the dura, the spinal ganglia were to some extent adherent; but it was uncertain if this adhesion was pathological. The dorsal nerves were of a light-grey colour as the result of degeneration, but the lumbar and sacral nerves showed no evidence of degeneration to the naked eye. Of the roots, the cervical were normal in colour, the lumbar and upper dorsal partly grey and partly white. The spinal cord was moderately soft, especially in the lower dorsal region, and the grey matter was hyperæmic in the cervical and dorsal portions.

The microscopical changes were most striking in the lower cervical and upper dorsal region, and less so in the lower dorsal and lumbar enlargement. There were no changes in the upper cervical region.

In the first-named regions—especially in the upper dorsal—the posterior roots were almost entirely degenerated throughout, but the anterior roots showed a less intense fibro-degeneration. In the cord evidence of degeneration was most pronounced in the upper dorsal and lower cervical parts—the region of maximum root affection. The columns of Goll and of Burdach;

* He is here referring to spondylitis deformans generally.

were the parts affected, and in the latter the degeneration corresponded to the entry of the posterior roots.

The degeneration in Goll's column began at the level of the 7th dorsal nerve-root and reached its maximum in the cervical part of the cord. A diffuse degeneration was present in the ventral columns in the upper dorsal and lower cervical cord and in the adjoining part of the lateral columns, also in the peripheral part of the cord in the region of the anterior roots. This latter was most marked in the cervical cord, and was apparently related to the nerve-roots themselves. The former corresponded to a system of sensory paths which cross in the anterior commissure.

The grey matter of the cord showed no changes, but in the spinal-root ganglia many cells were degenerated and atrophied and showed leucocytes in their interior. There was slight degeneration of the peripheral nerves, which was continuous with that of the roots. The atrophied muscles showed loss of cross-striation and fatty degeneration of the muscular fibres.¹¹

On these findings Von Bechterew suggested that the degeneration of the posterior roots was to be explained by the chronic (inflammatory) process in the meninges which resulted in compression of the roots at their point of entry into the cord, and in the adhesion of the spinal ganglia to the dura mater and the surrounding connective tissue. The meningeal mischief was therefore the primary condition, and the degeneration of the spinal nerves secondary to it. The nerve degeneration led to paresis of the muscles and inability to maintain the erect posture and the balance of the head, and these in their turn were responsible for the kyphosis. The abdominal respiration was to be attributed to the parietic state of the intercostals. Finally, the kyphosis caused compression and atrophy of the discs until the bone surfaces came in contact anteriorly, when bony union followed.

Much interest attaches to this post-mortem corroboration of Von Bechterew's observations, and to his conclusions. The latter, in view of the uncertainty as to the pathological adhesion of the ganglia to the dura, would seem to rest upon a somewhat insecure basis, and further investigations are desirable before the pathology of this type of spondylitis muscularis can be considered to be settled.

From Goldthwait¹² we get the impression that root symptoms are due to the pressure of inflammatory swelling at the intervertebral foramina resulting from the disease in the region of the transverse processes, and that, as we might expect if that is so, the symptoms usually improve, though in many instances recovery is never complete. He also mentions that a pressure paralysis very similar to that seen in Pott's disease may result from osseous deposit in the posterior ligament, and that relief of the symptoms usually takes place.

SPONDYLITIS SENILIS.

The spinal changes associated with old age may be regarded as a variation of spondylitis muscularis. Weakness and atrophy of the muscles progress simultaneously with the shrinkage and disappearance of the intervertebral substances. Probably both result from degenerative changes in the cardiovascular system. The disappearance of the discs alone is sufficient to produce

a marked dorsal kyphosis, but as, during life, the mechanical situation steadily alters for the worse from this cause, the failure of muscular power that accompanies it will aggravate the deformity. The following extract from Morris's *Anatomy of the Joints* (p. 70) will help these senile changes to be understood.

"The intervertebral substances vary in shape with the bodies of the vertebrae which they unite. They have therefore a wider area the lower they are situated in the column. Their thickness is also greater in the lumbar region. Together they form nearly one quarter of the whole length of the column—so that in a column of 28 inches, the intervertebral substances together measure about 7 inches. Their total length along their front aspect is greater than that along their posterior surface, and this difference is chiefly due to the cervical and lumbar substances. Thus they are the cause of the convexity forwards in the cervical region, and increase that in the lumbar.

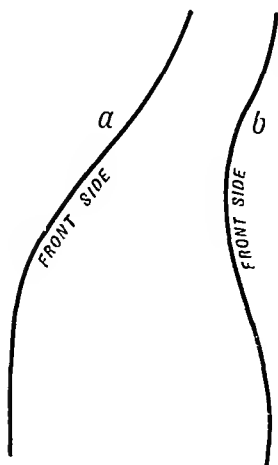


FIG. 321.—Diagram after Morris.



FIG. 320.—Another example of spondylitis ossificans ligamentosa, showing ossification in front of the bodies, bony ankylosis of the articular processes and of the ribs to the vertebrae (No. 2050, R.C.S. Museum).

It will be seen on referring to Fig. 321 how great is the difference in the curve of the spine (b) in the recent state, and (a) in the dry, after the intervertebral substances have been removed and the vertebrae are placed in close contact with each other, both with respect to their bodies and articular processes. In the dry state the convexity of the cervical and lumbar regions almost disappears, and the vertebrae present one great curve the concavity of which looks forward and is most marked a little below the middle of the dorsal region. Such is the curve of old age, owing to the shrinking and drying up of the intervertebral substances, which in their perfect state not only straighten out the column, but give to it the forward projections in the cervical and lumbar regions, and produce those gentle curves which have led in all ages to its being called 'the line of beauty'. The concavity forwards

of the dorsal region is almost entirely due to the shape of the bodies of the vertebrae, but it is somewhat increased by the intervertebral substances."

Museum specimens of uncomplicated senile changes in the spine are astonishingly rare. In the R.C.S. Museum (No. 2108, Hunterian specimen--



FIG. 322.—Spondylitis (muscularis) senilis
(No. 2108, R.C.S. Museum).

Fig. 322) is a preparation which is believed to be the result of old age. It shows a posterior curve of the upper dorsal spine. The curve amounts almost to a right angle and involves the dorsal vertebrae from the 2nd to the 7th. Nearly all the dorsal intervertebral substances are obliterated or extremely narrow. The anterior parts of the articular surfaces of the bodies from the 3rd to the 7th appear to be fused. There is no ossification of the ligaments.

In the Birmingham University Pathological Museum is another (No. 93 (04.7) 85.2), probably of a similar nature. It shows a kyphotic curve of the dorsal spine to a right angle having the 7th and 8th dorsal vertebrae at its summit. The intervertebral substances (both lumbar and dorsal) have to a great extent been absorbed, and there is fusion of the bodies from the 4th to the 10th dorsal vertebrae. A thin layer of bone (anterior common ligament) is spread over the anterior surface of the concavity of the curve and is limited to the vertebrae men-

tioned, and there is slight ossification also of the ligaments between the 7th, 8th, and 9th spines.

In neither of these specimens is there sufficient evidence of osteo-arthritis to suspect that disease as the cause of the kyphosis, and in neither unfortunately are there any clinical notes.

PATHOGENESIS.

Abundant evidence points to the toxic origin of spondylitis ossificans ligamentosa. The toxins are usually derived from some infective focus. In many cases, though not in all, this is of a septic nature, and frequently it is gonorrhoeal. The connection is often so obvious that it cannot now be overlooked as it used to be in the days when micro-organisms and toxins were unknown.

In spondylitis muscularis, however, no such direct association is manifest, although in few cases can infection have been completely absent at all times throughout the development and duration of the disease. The muscular weakness which is the primary factor in the early stage may, it is true, be the consequence of some illness due to an infection, but only in this indirect way can the influence of toxins other than metabolic toxins be suspected.

The rôle which muscular weakness, atrophy of discs, trauma, heredity, and old age play in the evolution of the affection has already been considered in the foregoing account; but in particular cases other factors may be present. These would include an occupation entailing a stooping posture or the bearing of burdens upon the upper part of the spine; also undue rapidity of growth or great height, in both of which the muscular development is apt to be inadequate. Prolonged or late rickets obviously, or any debilitating illness, especially in early youth or adolescence, may predispose to this form of kyphosis; so also may myopia or a studious habit, and possibly even a morose temperament, especially if conjoined with a disinclination to a healthy outdoor athletic mode of life.

MORBID ANATOMY.

A comprehensive description of the morbid anatomy is difficult, because there are so few specimens and records on which it can be based. Its chief features, which have already been described in the accounts of the autopsy on Von Bechterew's case and museum specimens, are:—

1. A kyphotic curve in the upper or middle dorsal region, arising primarily from muscular weakness.
2. Pressure atrophy of the discs included in the curve, more particularly at their anterior parts.
3. This is followed by fusion of the anterior parts of the articular surfaces of the bodies, when, owing to the disappearance of the intervening portions of the discs, the bony surfaces of adjacent vertebræ are brought into contact.
4. Often a slight degree of lateral bending is present at the upper part of the curve, and on the concavity of this bend the bodies may be slightly compressed, the disc edges may have disappeared, and fusion of adjacent vertebræ taken place.
5. Owing to moulding of the rarefied cancellous tissue resulting from the combination of curves, the bodies may become altered in shape; the side-to-side diameter may be diminished and the antero-posterior slightly increased (*Fig. 322*). The compact tissue of the concavity may be strengthened by sclerosis. A similar need for increased strength was probably responsible for the purely local ossification of the anterior common ligament on the concavity of the curve in the Birmingham specimen described in the section on senile changes.
6. Lastly, in the senile form, atrophy of the discs is not limited to the region of the curve, but extends throughout the spine.

When spondylitis ossificans ligamentosa is compared with spondylitis muscularis, it seems remarkable that they could ever have been regarded as

simply different types of the same disease. Not only are the signs and morbid anatomy of the former quite different from those of the latter, but in each condition they are distinctive. The pathogenesis also is not the same.

The confused condition of our knowledge of spondylitis deformans arises not only from the absence of clinical notes from museum specimens, but also from the fact that the literature is largely composed of records of cases published during their lifetime. It is quite rare to come across a fully reported case with the results of a pathological examination attached. There can, however, be no doubt that spondylitis ossificans ligamentosa and spondylitis muscularis are distinct affections, and should be regarded as separate diseases.

III. CASES IN WHICH THE CHANGES ARE OF AN OSTEO-ARTHRITIC CHARACTER.

(*Spondylitis Osteo-arthritis.*)

Osteo-arthritis of the spine resembles the same disease in the joints of the extremities, but it presents certain remarkable differences. Those characteristic signs—the disintegration and removal of articular and interarticular cartilages, and the formation of marginal osteophytes—are as pronounced in the spinal joints as elsewhere. On the other hand, an absence of eburnation and some tendency to ankylosis are peculiar to the spinal affection.

It is easy to explain the absence of eburnation, for the amphiarthrodial joints connecting the vertebral bodies do not permit of such movement as is necessary for its production. The only joints between the articular processes (arthrodial) in which movement is tolerably free are the lateral atlo-axoid. There is free mobility also in the occipito-atloid joints (ginglymo-artrodial). It is in these joints that eburnation might be expected to occur, and the only articulations in which I have found it well marked were an atlo-axoid (see *Specimen 6 infra*) and one between the 3rd and 4th cervical vertebræ in a case where the axis and 3rd cervical were fused (*Specimen 7*). Bony ankylosis of the spine in osteo-arthritis is not so frequent as it is believed to be. In museum examples of spondylitis ossificans ligamentosa largely predominate over those of spondylitis osteo-arthritis, and as these are very commonly described as osteo-arthritis, confusion naturally results.

A study of those specimens which are unmistakably the result of osteo-arthritis, and in which the diagnosis was elined, with reasonable frequency for museum specimens, by a record of osteo-arthritis in other joints, showed that fusion of the articular surfaces of the bodies and of the articular processes was unusual, that ankylosis of the ribs to the vertebræ had not occurred, and that the laminae and spinous processes were not united by bone. When bony ankylosis was present it was commonly due to the fusion of the osteophytic lipping of adjacent vertebræ, but more often, even in advanced cases, the line of contact persisted without fusion. Fusion of the vertebral bodies did occasionally occur, but it was under circumstances in which pressure and probably complete immobility were evidently determining factors. It was noticeable that the joints in which the atlas participated were liable to

bony ankylosis when attacked, and when ankylosed exhibited no sign of osteophytes.*

A study of the following descriptions will show the justification for these statements.

Specimen 1.—The lower dorsal, lumbar, and sacral spine of an aged female (No. 2048, R.C.S. Museum: Sir J. E. Erichsen) shows marked osteo-arthritis changes (Fig. 323). The discs must have been destroyed in all the lumbar joints except the lumbar sacral. Contiguous articular surfaces of the bodies of the 1st and 2nd lumbar vertebrae and also of the 4th and 5th present complete areas of uneven rarefied bone whose inequalities appear almost as if adapted to fit together. There is no ankylosis of any of the vertebrae, though the outspread marginal lippings of adjacent vertebrae have evidently been in contact in many places.

Two other specimens from the same patient illustrate osteo-arthritis of other joints: No. 1989 is a left shoulder-joint, and No. 1905 is a beautiful example of advanced osteo-arthritis of the knee. It is surprising that fusion of the vertebral bodies had not taken place in this case. Fibrous tissue must certainly have united the 1st and 2nd, and the 4th and 5th lumbar vertebrae, and ossification was probably advancing into it and across it to convert a fibrous into a bony ankylosis; but the ossifying process was evidently very slow, and the new trabecula had not consolidated sufficiently to withstand the effects of maceration.

* In a series of papers of exceptional interest Arbuthnot Lane¹³ advanced the view that "pressure or force applied in one form or another is the chief if not the sole factor" in the production of the changes in osteo-arthritis. In developing his thesis Lane pointed out that "the vertebral column and the joints connected with it reacted to pressure in three different ways according to the manner it is exerted upon the bones and joints".

1. The changes due to *direct transmission of pressure* constitute the first group. They are:—

a. Bones are rendered more dense and strong; this is most marked at points of greatest strain.

b. Intervening soft structures are removed—namely, interarticular fibrocartilage, articular cartilage, interspinous ligaments, ligamenta subflava.

c. With the removal of the cartilage, the subjacent bone becomes dense, and marginal lipping takes place. Adjoining vertebrae may be partially synostosed by fusion of these bony outgrowths.

d. On complete removal of the intervening soft parts, fusion of the vertebral bodies may take place, also fusion of the laminae, the spines and the articular processes, the sacro-iliac synchondroses and symphysis pubis.

2. The second group of changes depends upon *great tension of the ligaments*, a condition the reverse of transmission of pressure.

The spinous processes increase in density and size, encroaching upon the normal area of the ligaments connecting them. They may even become united by bone. These effects are seen in an antero-posterior curve that has to support much weight. When the spine is over-extended ossification of the anterior common ligament may ensue.

3. The third group of changes is brought about by *an oblique incidence of pressure*: as when an antero-posterior upper dorsal curve is produced by carrying heavy loads upon the upper part of the head and neck. Destruction of the cartilages and displacement of the bodies of the vertebrae are prevented by abundant callus which joins the margins of adjacent vertebrae and bridges the cartilages. These show but slight pressure change.

Lane supported his argument by referring to the fusion of the lumbar vertebrae seen in the extinct giant sloth (R.C.S. Museum), attributable, as he believed, to the great weight that was transmitted through them. A similar fusion, probably traceable to a like cause, occurs in the cervical vertebrae of the whale, the porpoise, and the armadillo, and also in the marsupial mole of Australia, a burrowing animal which also shows a horny shield on its snout. In the ordinary field mole there is no fusion of cervical vertebrae and no horny plate. Both moles, however, use their feet in burrowing.

Whatever opinions may exist as to the correctness of Lane's original conception, there can be no question that we owe to him the full recognition of the importance of pressure, and tension of ligaments, in the production of osteo-arthritis changes. It is also fair to note that in a later work he expressed an opinion as to the toxic factor in the causation of osteo-arthritis which is in harmony with the trend of thought at the present day.

Specimen 2.—One of John Hunter's specimens (No. 2049, R.C.S. Museum) shows lipping of most of the vertebral bodies, particularly of those in the lumbar region. The costovertebral articulations have also suffered, and some of the laminae in the dorsal region are affected. There is no ankylosis of the ribs, or of the articular processes, and no fusion of the vertebral bodies, but union has occurred in a few places where adjacent osteophytic protrusions have come into contact.

Specimen 3.—A third specimen (No. 2107, R.C.S. Museum: Robert Liston), said to be the spine of an old woman, shows marked lipping in the lumbar region, where there is no ankylosis. Several dorsal vertebrae are united by fusion of osteophytes, but only the bodies of the 4th and 5th dorsal vertebrae are ankylosed by fusion of their articular surfaces. These two vertebrae are hardly lipped at all, and are situated just above the most prominent part of a long dorsal kyphosis. The peculiarity of the curvature rather suggests that the changes of old age are added to those of osteo-arthritis.

Specimen 4.—In another case (No. 1085, St. Bart.'s Hosp. Museum) several dorsal vertebrae are united by ossification of the anterior common ligament. There is marked lipping in the dorsolumbar region, but no fusion of the articular surfaces of the bodies and no ankylosis of the ribs or articular processes. The patient's left knee had been excised for rheumatoid arthritis. (In all probability this means osteo-arthritis.)

Specimen 5.—Marginal osteophytes arise from all the lumbar vertebrae in No. 1085a, St. Bart.'s Hosp. Museum, and the 2nd, 3rd, and 4th are united by a mass of hard bone at the part where the psoas muscle is attached to them.

Specimen 6.—There is in the Manchester University Museum a specimen of unusual interest (No. 93. 85. 2). It is an occipital bone with which the atlas is fused. The left inferior articular surface of the latter bone—on the under surface of its lateral mass—is so worn down that none of its original surface remains. It is surmounted by a rough flange of osteophytic deposit, and is marked by parallel ridges of eburnated bone corresponding in direction with the revolving movement of the joint. But besides this, the atlas is greatly atrophied and the portion of its posterior arch (nearly half) adjoining the osteo-arthritic articulating surface has disappeared. (Cf. Case 3.)

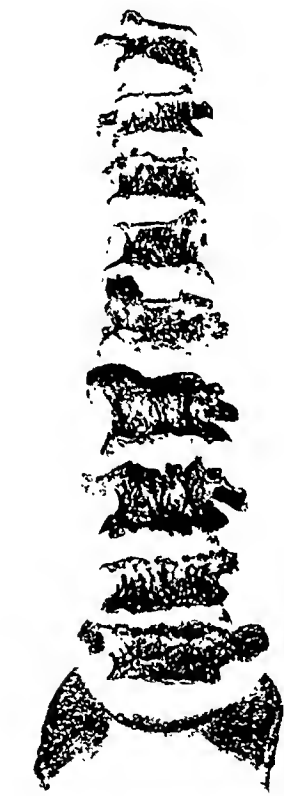


FIG. 323.—Spondylitis osteoarthritis. The bodies are held apart by nuts upon an iron rod (No. 2048, R.C.S. Museum).

The disappearance just referred to is doubtless the result of pressure, partly from the lateral canting of the head and atlas that must have been present, and partly also from the osteophytic outgrowth. The atlas-occipital joints and all that remains of the atlas are firmly synostosed, but there is no lipping at these joints.

In this specimen, in close relation, are three joints greatly changed. In one the changes are diagnostic of osteo-arthritis; in the other two there is ankylosis without the accepted signs of osteo-arthritis, but associated with other changes evidently the result of pressure and partly of disuse. Clearly we must assume that the arthritis is of the same nature in all three cases,

i.e., osteo-arthritis, and that the presence or absence of movement determines the different appearances. It is an illustration of Arbutnot Lane's aphorism that pressure, after removal of cartilages, will cause fusion if there is no restitution of movement. The fusion of the two dorsal vertebrae in Liston's specimen (*Specimen 3*) is similarly explainable.

It might be suggested that the osteo-arthritic joint was the secondary effect of a congenital synostosis. It is unfortunate that there should be no information as to the condition of the rest of the spine or the other joints, either in this or the next case, but in the light of *Case 3* (p. 532) I do not think this theory can be seriously entertained.

Specimen 7.—A somewhat similar specimen to the preceding one is No. 2021D in the R.C.S. Museum (*Fig. 324*). In this it is the inferior articular facet of the 3rd cervical vertebra on the left side which presents the ordinary signs of osteo-arthritis, being deeply worn, eburnated and pitted, and widely lipped with new bone, whilst the axis and the 3rd cervical vertebra are synostosed—joints, bodies, and arches—a condition attributed in the catalogue to congenital defect. The specimen was from a heavy woman of 45 who died after a fall downstairs in consequence of a fracture-dislocation (through the odontoid process) between the atlas and axis, with tearing across of the left vertebral artery.



FIG. 324.—Spondylitis osteo-arthritica. Notice the encroachment of the lipping of the body, and also of that of the articular process upon the upper half of the left neural foramen, which might have caused nerve-root symptoms (No. 2021D, R.C.S. Museum).

False Lipping.—Bony protrusions corresponding in position to the intervertebral substances are not necessarily marginal osteophytes or evidence of osteo-arthritis. A moniliform row of such prominences is a frequent feature in spondylitis ossificans ligamentosa and is often regarded as pointing to osteo-arthritis. The abnormality is produced by atrophic changes in the vertebral bodies, and has already been referred to.

Specimen 8.—There are two specimens in the Birmingham University Museum which are significant (Nos. 93 (04.7), 85, 2a and 2b). Together they complete six vertebrae—part of a dorso-lumbar curve which has been divided sagittally. Ankylosis has resulted from ossification of the anterior common ligament and portions of the discs in places. On the left side a vertical row of bosses covers the edges of the discs and the adjacent portions of the sides of adjoining vertebrae, suggesting lipping beneath the lateral margin of the ligament.

On careful investigation it is seen that the phenomenon is produced by atrophic shrinkage of the bodies on that side, deepening the natural concavity of their surfaces and throwing the normal elevations due to the edges of the discs into marked prominence.

The right halves of the bodies retain their normal breadth and shape, and are a great contrast to the contracted left halves. In the lower part of the specimen the protuberances are less marked and the atrophy not so excessive.

Specimen 9.—In the R.C.S. Museum there is a well-known specimen (No. 2105A) which may explain the nature of the ‘lipping’ so often noticed on the concave surfaces of curves in scoliosis. It shows a lateral lumbar curve of exceptional severity with very prominent protrusions on the concave surface between the bodies. A side-to-side section has been made, and both vertebræ and discs are seen to have acquired a wedge-shaped form with their bases at the convexity of the curve. The apices of the discs show degeneration and atrophy, and in company with the adjoining cancellous tissue on each side, have been elongated outwards on the concave surface, until deep gulfs have been produced in the sides of the bodies between these promontories. Except for this moulding by long-continued pressure, the bone on the face of the section appears only closer where it has been compressed, and shows none of the irregularity which is caused by marginal osteophytes.

I am greatly indebted to the kindness of the curators of the various museums from which I have been permitted to draw much of the material on which this article is based, and also to several friends, particularly Dr. L. J. Kidd and Mr. Plarr, for their willing help in extricating me from the pitfalls of German translation. To all of them I am very grateful.

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SUBPERITONEAL EFFUSIONS SIMULATING ACUTE INTRAPERITONEAL DISEASE.

By J. L. JOYCE, READING.

THE simulation of acute intraperitoneal disease by certain extraperitoneal disorders has long been recognized by surgeons, but writers on acute abdominal disease do not seem to have noticed that this simulation may be produced in a striking manner by a rapid effusion of blood, pus, or serum into the subperitoneal tissues.

My attention was first attracted to this subject by a disaster. I had been asked to remove a fibromyoma of the uterus. The operation was to have been at 8.0 a.m. on the day arranged in a small nursing home, but on the previous evening I was summoned to the home about 11.0 o'clock because the patient had been seized a few hours earlier with acute abdominal pain and vomiting. On my arrival I was told that the patient had begun to complain of severe pain in the lower part of her abdomen during the administration of a soap and water enema at 7.0 p.m., and that she had twice vomited. The patient maintained that the enema was the cause of her illness, and so insisted on this that the nurse who had given the enema, and who had retired to bed, was fetched from an adjoining house to give her version of what had occurred. The nurse stated that she had given the enema with a Higginson's syringe, and that she had passed its bone nozzle through the anus without difficulty. The patient had complained of severe pain in the abdomen after the injection of two or three ounces of the soapy water. The nozzle was withdrawn, and a little blood the nurse had seen on it she attributed to some bleeding piles which were known to be present. After waiting a few minutes, the nurse completed the administration of the enema, and the patient returned the injection with some flatus but without relief of her pain.

The patient had an anxious facial appearance, and was lying on her back with her knees flexed. The temperature was 97° and the pulse-rate 112. The lower part of the abdominal wall moved poorly on respiration and was tender and rigid. On vaginal examination a rounded swelling was found in Douglas's pouch, but the tenderness and rigidity made bimanual examination difficult, and the nature of the swelling could not be determined. Rectal examination was painful; the swelling in Douglas's pouch was felt, but nothing more about its nature was learnt. Some prolapsed piles were seen at the anus, but they were not bleeding.

A medical colleague, in consultation, agreed that some acute intraperitoneal disease was present, probably a twisted ovarian cyst, and that an emergency operation should be performed.

The abdomen was explored through a paramedian incision; the subperitoneal tissues were oedematous; a pedunculated fibroid of the uterus

was the swelling which had been felt in Douglas's pouch, but no intraperitoneal lesion was found which could account for her acute symptoms. Leaving a small drain down to the peritoneum at the lower end of the incision, the abdomen was closed. Next morning the patient was desperately ill; by the evening she was dead.

A limited post-mortem examination was made. The subperitoneal tissues of the pelvis were grossly infiltrated with a seropurulent effusion. A rosette-shaped mass of œdematous piles, which had prolapsed from the right side of the anal canal, projected from the anus and covered its orifice. A hole in the centre of the piles led to a track which ran upwards and forwards into the pelvic tissues outside the rectum. As the examination proceeded, an escape of soapy water through the track explained what had happened: the nurse, mistaking the centre of the rosette-shaped mass of piles for the anal orifice, had pushed the nozzle of the enema through that and injected a portion of the soap and water into the loose cellular tissues outside the rectum. The rapid effusion of inflammatory serum into the subperitoneal tissues of the pelvis, which followed the injury, gave rise to symptoms and signs closely resembling those of an acute intraperitoneal disease.

A similar accident recorded by Fletcher Shaw¹ was not fatal, but resulted in occlusion of the lower part of the rectum. For many years nurses trained in Reading have been taught to give enemata from funnels through soft rubber catheters: a practice worthy of universal adoption.

The need for careful differentiation between subperitoneal streptococcal infections and appendicitis has been noticed by Connell², who quotes J. B. Murphy, "the greatest stress should be laid on the differential diagnosis between intra- and subperitoneal infections".

Acute osteomyelitis of the spine is mistaken sometimes for acute intraperitoneal disease.

Fraser³, reporting a case of that disorder, notes the resemblance. One of two of my patients suffering with acute osteomyelitis of the spine at first seemed to be suffering from acute peritonitis, and an unnecessary laparotomy was performed. A boggy œdema, which extended into the pelvic mesocolon, was found over the sacrum behind the posterior parietal peritoneum. A correct diagnosis was reached the next day, but in spite of several operations to procure drainage the patient died a month later. At the post-mortem examination it was found that the disease had begun in the body of the 2nd sacral vertebra. In cases of acute osteomyelitis of the spine and in subperitoneal infections the outpouring of inflammatory serum into the extraperitoneal tissues is the cause of the symptoms and signs which mimic those of acute intraperitoneal disease.

An effusion of blood may act in a like manner: A bootmaker, age 48, was sitting in his chair reading a paper. He was suddenly seized with an acute pain in the left iliac fossa, and in the four hours' interval between the onset of his illness and his admission to hospital he vomited four times. He had been invalided from France during the war for 'lumbago and sciatica', and had been treated for this condition by the Ministry of Pensions for some months, but previous to being taken ill was in his usual health. Some years before he had had an operation for a left inguinal hernia.

The patient, a well-nourished man, had a muddy complexion and a furred tongue. A squint obscured his expression, but he was obviously suffering pain. His temperature was 97° and his pulse-rate 76. No abnormal physical signs were found in his chest. His abdomen was distended and its respiratory movements were restricted. The scar of the hernia operation was visible in his left loin, but the hernia had recurred, and a distended sac was seen in the left side of his scrotum.

The abdomen, particularly over the left iliac fossa, was tender on palpation. The hernia contained intestine which was easily reduced, but the patient complained of pain when reduction was effected, and the hernia quickly recurred. The superficial reflexes were absent. The left side of the abdomen was rigid. On percussion the liver dullness extended one finger-breadth below the sixth rib in the nipple line. The right side of the abdomen was tympanitic; lateral to a vertical line situated two inches to the left of the umbilicus, the left side of the abdomen was dull. When the patient was rolled on to his right side the dullness did not shift, and between the tympanitic note on the right side and the dullness on the left the line of demarcation was abrupt and well defined. By rectal examination nothing abnormal was found, and a turpentine enema was returned without feces or flatus. His urine contained a trace of albumin, but was otherwise normal.

Acute intestinal obstruction was diagnosed, and I thought the cause might be a band in connection with the left inguinal hernia. The abdomen was opened below the umbilicus by a left paramedian incision. The explanation of the physical signs elicited by percussion was then apparent: the descending colon had been pushed forwards and towards the middle line by a large hæmatoma which had stripped up the peritoneum on the outer side of the gut. The descending colon was collapsed, whereas all the intestine proximal to it was distended. The hæmatoma extended from the region of the left kidney to the root of the pelvic mesocolon. The kidney itself, obscured by the large mass of the hæmatoma, was not felt.

The further steps of the operation were improvised on the assumption that the probable diagnosis was a ruptured aneurysm of the left renal artery. An incision was made through the posterior parietal peritoneum over the aorta and a dissection carried upwards; on reaching the left renal vein it was divided between ligatures just distal to the entrance of the spermatic vein. Next, the left renal artery was divided close to its origin from the aorta. The opening in the posterior parietal peritoneum was then closed. The peritoneum on the outer side of the descending colon was now incised, and after clamping and cutting through the ureter, a large mass, consisting of perirenal fat, blood-clot, and the left kidney with its divided vessels, was brought forward and removed. After clearing away the remaining blood-clot, tying all bleeding vessels, and suturing the incision in the peritoneum on the outer side of the colon, the abdomen was closed. The patient recovered. The specimen was examined by Dr. Keith, who reported that the growth was an angioma.

In the foregoing case, a rapid extravasation of blood into the retroperitoneal tissues of the loin produced acute intestinal obstruction. The cause of the obstruction was not recognized to be extraperitoneal, and was sought

for within the peritoneal cavity. Other surgeons have experienced this difficulty in exact diagnosis. Sohn⁴ has recently reviewed the history of cases of spontaneous perirenal hæmorrhage reported in surgical papers since 1910, and adds two cases of his own: in one he performed an exploratory laparotomy on the diagnosis of acute intestinal obstruction. Bolland⁵, describing a case of spontaneous hæmatoma in sarcoma of kidney, writes: "At 10.0 a.m., August 23, 1922, while walking, she was seized with a sudden violent pain in the left loin, accompanied by extreme weakness, faintness, and nausea. She was taken home and seen by her physician within two hours of the onset of the condition. He found her in a state of collapse, with a very weak pulse, a distended abdomen, and an easily discernible mass in the left loin. She was then vomiting, and on account of this symptom, and the distention, his first thought was of intestinal obstruction." Wood⁶ has recorded a case of spontaneous rupture of a hydrourephrosis into the retroperitoneal tissues of the left loin, in which the abdomen was opened because "it was thought that the condition might possibly be a ruptured ovarian cyst".

Even should the diagnosis of a subperitoneal effusion be certain, so close may be the simulation of acute intraperitoneal disease that the surgeon may think some intraperitoneal complication has ensued. This is well illustrated by a case of "Rupture of Renal Artery and Vein by Slight Injury" recorded by Miles Atkinson,⁷ from which the following extracts are quoted:—

A boy of 18 was admitted to the Prince of Wales Hospital with hæmaturia. Two days previously he fell while playing cricket and pushed his elbow into his left side. . . . On admission he did not look ill. . . . The whole of the left side of the abdomen and left flank were rigid and tender sufficiently to make examination difficult; but palpation of the left kidney region revealed indefinite swelling below the costal margin which was dull to percussion. . . . His bowels not having been opened since the accident, he was given an enema, with no result. The following morning there was no result from an enema. In the afternoon he suddenly vomited three times, looked rather distressed. . . . the abdomen was somewhat distended, tympanitic on the right side, with no evidence of free fluid. . . . The temperature was 101°, the pulse 126. . . . Having regard to the onset of abdominal signs it was thought possible that at the time of the accident there had been a tear of the peritoneum, that since then there had been a gradual leak of urine into the peritoneal cavity, and that now a spreading peritonitis was beginning. . . .

The abdomen was opened by a left paramedian incision. The descending colon was found pushed forward by a large retroperitoneal hæmatoma extending from the region of the left kidney down to the brim of the pelvis. This piece of intestine was small and contracted, but proximal to it the whole intestinal tract was definitely distended. There was no peritonitis. Apparently the large hæmatoma had so interfered with the action of the descending colon as to paralyse it temporarily and cause an intestinal obstruction which enemata had failed to relieve.

Under the title, "Rupture of the Abdominal Aorta: Death from Acute Intestinal Obstruction", Nicory⁸ has described a somewhat similar case, in which the hæmorrhage took place into the retroperitoneal tissues on the right side from a hole in the right wall of the aorta 15 mm. above its bifurcation.

In these cases no exact account is recorded of the physical signs which might have been elicited by percussion; but, judging from the records of the operations and post-mortem examinations, there can be little doubt that, had they been looked for, those signs would have been found which were described in the case of the bootmaker, namely, fixed dullness in the loin.

a tympanitic note over the rest of the abdomen, and a sharp line of demarcation between these areas.

Subperitoneal effusions, then, may give rise to symptoms resembling those of acute intraperitoneal disease: large effusions situated in the loin may produce acute intestinal obstruction, but they give rise to characteristic physical signs on percussion. Appreciating these principles, I reached a correct diagnosis in the following cases:—

A post-office employee fell forty feet from a telegraph post on to his buttocks. His pelvis was fractured, and his distended bladder was ruptured, with extravasation of urine into the retroperitoneal tissues of the left iliac fossa. A distended abdomen, with motionless, tender, and rigid walls, suggested intraperitoneal injury. The recognition of the principle that intraperitoneal diseases may be simulated by extraperitoneal effusions, and the detection by percussion of an area of fixed dullness in the left iliac fossa, abruptly separated from a tympanitic note over the rest of the abdomen, led me to the diagnosis of extraperitoneal rupture of the bladder without intraperitoneal injury. The diagnosis was confirmed at operation by finding an extraperitoneal rupture of the bladder on its left lateral wall, and by the absence of any signs of intraperitoneal injury three weeks later at the post-mortem examination.

One afternoon I was asked by my colleague, Dr. Rowland, to see a man of 49 who five hours earlier had been seized with violent abdominal pain. For six weeks the patient had been under treatment for 'left sciatic neuritis'. At first the sciatica was so severe that the patient was confined to bed, but for some days he had been better: arrangements having been made for him to have a course of baths, he was to have travelled to an inland spa on the day he was taken acutely ill. Intending to leave about midday he had a late breakfast and afterwards visited the lavatory. Just after going to stool he was seized with a violent pain in the abdomen and collapsed on the lavatory floor, where, after a few minutes, he was discovered by his wife, who described his appearance as 'blue and covered with sweat'. He was carried back to his bed, and during the next few hours vomited several times.

When I examined the patient he was lying recumbent with his knees flexed; his face was pale and drawn, and he was obviously in much pain and dreaded the slightest movement. He complained bitterly of being unable to pass wind, and said that if he could do this he would be easier. His temperature was 97° and his pulse 120. The abdomen was distended, and barely moved with respiration.

Everywhere to the left of the middle line the abdominal wall was intensely rigid and exquisitely tender, but the most remarkable of the physical signs was the contrast on percussion between a fixed dullness in the left loin and a tympanitic note over the rest of the abdomen. A sharp vertical line of demarcation which could be traced from the costal margin to the pubis, two inches to the left of the middle line, separated the two areas of altered resonance. No swelling was visible, and deep palpation was impossible because of the tenderness and rigidity. The right thigh could be extended with ease, but passive extension of the left thigh was painful. Compared with the right, the volume of the pulse in the left femoral artery was distinctly smaller. On

careful auscultation over the heart, the aorta, and the iliac and femoral vessels, no abnormal sounds were heard. The rectum was empty and collapsed, and no swelling could be felt or any particular tenderness elicited. The urine had a specific gravity of 1020 and contained no albumin, sugar, blood, or pus. The cremasteric reflexes and knee-jerks were present and the plantar reflexes were flexor. A diagnosis was made of a sudden retroperitoneal effusion into the left loin, and the probable source of the effusion was thought to be a ruptured aneurysm. Operative exploration was advised. The patient was admitted to the Royal Berkshire Hospital under the care of my colleague, Mr. Baxter, who, knowing my interest in the case, kindly allowed me to operate while he, in case of need, prepared to carry out a blood transfusion.

The abdomen was opened by a left paramedian incision and the diagnosis of a retroperitoneal hæmorrhage was confirmed. The descending colon was collapsed and pushed inwards and forwards by a large hæmorrhage which had stripped up the peritoneum on the outer side of the colon. The raised peritoneum was then incised, exposing a large hæmatoma which occupied the space between the kidney above and the pelvis below. The hæmatoma was larger below than it was above, and remembering the pain which extension of the left leg had caused, and the diminution in volume of the left femoral pulse, I thought that the probable lesion was a ruptured aneurysm of one of the iliac vessels. The blood-clot was carefully removed and a dissection carried inwards until the psoas muscle came into view, when it was seen that the sheath of the muscle was greatly distended with blood-clot. At a point on the antero-lateral aspect of the muscle, opposite the level of the anterior superior iliac spine, there was a hole in the sheath about an inch long from which blood issued. The source of the hæmorrhage was then sought for in a different direction; palpation along the course of the aorta through the posterior parietal peritoneum revealed a large tense rounded swelling with expansile pulsation at the level of the celiac axis. By this time the patient's condition was critical, and as control of the hæmorrhage seemed impossible, no further exploration was made.

The abdomen was closed, and a few hours later the patient died. Unfortunately no post-mortem examination was allowed, but it was evident that an aneurysm of the abdominal aorta, or of one of its branches in the region of the celiac axis, had ruptured posteriorly into the psoas sheath. The hæmorrhage had dissected down the psoas, and after rupturing the sheath of the muscle, had made its way into the loose retroperitoneal tissues of the left loin.

In connection with our subject the following extract from a recent paper on "Injuries to the Kidney and Ureter" by Hamilton Bailey⁹ is significant: "In many cases of severe renal injury abdominal distention is seen, and may give rise to difficulty in precise diagnosis. Theoretically, it might be reasonably conjectured that early and obvious signs of a severely damaged kidney would mask an intraperitoneal complication, such as a ruptured intestine, and if this were so, a ruptured kidney might be explored and dealt with effectively via the lumbar route whilst an (additional) intraperitoneal complication was unavoidably overlooked. Between 1893 and 1923 no such case occurred at the London Hospital, from which the comforting conclusion can be drawn that in a given case of severe abdominal injury, if the patient rallies from the

shock and the signs are definite enough to indicate that the kidney has been severely damaged, subsequent meteorism does not, as a rule, imply a dual lesion, and the case can continue to be treated expectantly as far as the peritoneum and its contents are concerned. De Quervain suggested that abdominal distention, following a renal injury, was due to interference with the blood-supply of that portion of the colon overlying the kidney. The records of the London Hospital support this view."

CONCLUSIONS.

1. A rapid effusion of blood, serum, pus, or urine into the retroperitoneal tissues may simulate acute intraperitoneal disease.
 2. A sudden and massive effusion into the retroperitoneal tissues of either loin can cause acute intestinal obstruction.
 3. A large retroperitoneal effusion in the region of the loin gives rise to a striking and characteristic sign on percussion. Corresponding to the site of a displaced and collapsed ascending or descending colon, there is an abrupt line of demarcation between a fixed dullness in the loin and a tympanitic note over the rest of the abdomen.
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- ⁷ ATKINSON, MILES, *Brit. Med. Jour.*, 1923, i, 324.
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MATERNAL BIRTH PALSY.*

By C. LAMBRINUDI, LONDON.

WITHIN the last six months I happen to have seen two cases of traumatic maternal birth palsy. Since this condition is extremely rare, I thought it was worth while to record them and give a brief outline of the theories of etiology.

DESCRIPTION OF CASES.

Case 1.—The first case was under the care of Mr. Laning Evans at the Royal National Orthopædic Hospital, and shown by him at the Orthopædic Section of the Royal Society of Medicine in November, 1923. She was a primipara, 30 years of age, who had experienced a normal pregnancy. Labour lasted 14 hours. There was a slight general contraction of the pelvis, and high forceps were applied. The child was born alive, though cyanosed and apnœic, and weighed 6 lb.

Immediately on recovering from the anæsthetic the patient felt a numbness and weakness in the whole of her right leg. On getting up three weeks later, she noticed acute pain along the back of the thigh and outer part of the leg and foot; she also had definite foot-drop. The patient when seen five months after her labour showed a paralysis of the toe extensors, the tibialis anticus, and the peronei, with some weakness of the toe flexors. The electrical responses were those of a partial reaction of degeneration.

Voluntary power began to reappear in the tibialis anticus muscle after five weeks' treatment, and, when seen seven months later, she was progressing well.

Case 2.—The second case, under Mr. Trethowan at Guy's Hospital, was a woman of 25. Three years previously she had lost her first child during a difficult labour in which the child's shoulders became impacted. A second pregnancy was normal, but she was examined one month before full term and was noted to have a flat pelvis. For this reason, she was admitted into Guy's Hospital for her labour, which lasted 17 hours. The foetal head occupied a left occipito-anterior position, and the child was born alive and uninjured without the aid of forceps. It weighed 7½ lb.

During the second half of the labour she noticed very acute cramp in her right leg below the knee. She felt a great relief afterwards, but a feeling of weakness and numbness persisted. On getting up three weeks later, she noticed a right foot-drop.

When first seen she had definite paresis of the muscles supplied by the external popliteal nerve and a dullness of sensation in its distribution. After two weeks the sensation had recovered, but the muscular weakness remained.

ETIOLOGY OF THE CONDITION.

These are two typical cases of traumatic maternal birth palsy. In both the pelvis was contracted and labour difficult; in both the symptoms were definitely associated with labour, and the signs predominated in the

* A paper read before the Annual Meeting of the British Orthopædic Association, 1924.

distribution of the external popliteal nerve. Sensation was impaired only in the second case.

There could be no question of the involvement of nerves in an inflammatory exudate, because the symptoms immediately followed the labour, the puerperium was normal, and the vaginal examination was negative. Neither could the foot-drop be attributed to pressure of the external popliteal nerve against the head of the fibula by leg crutches, because, in the first case, the flexor longus digitorum was involved, a muscle which is supplied through the internal popliteal nerve; in the second case no leg crutches were used.

Churchill, writing in the *Dublin Journal of Medical Science* in 1845, quoted two similar cases described by Campbell and Ranisbottom, which were attributed to pressure exercised on the muscles and pelvic nerves during the passage of the foetal head. He, however, dismisses them with the remarks: "If we recollect the number of severe and prolonged instrumental deliveries which take place without any such result, I think we must reject this peculiarity of labour as a necessary or frequent cause."

The two most quoted papers on the subject are those of Bianchi and Lefèvre, in 1867 and 1876 respectively. They advanced the theory that the paralysis was due to pressure, during the course of difficult labour, of the foetal head or forceps on the lumbosacral cord at the pelvic brim before it enters the plexus. From that time onwards this theory has been generally accepted.

Thomas, writing in the *Johns Hopkins Hospital Bulletin* in 1900, elaborated this theory, and explained the frequency with which the external popliteal nerve is picked out, as follows: "The upper roots of the sacral plexus do not lie on the pyriformis muscle, but against the bony wall of the pelvis, and are thus exposed to pressure during certain difficult labours. It is the dorsal offsets of these roots which lie against the bone and receive the chief injury. The external popliteal nerve is made up of these dorsal offsets and therefore the paralysis is chiefly localized in the distribution of this nerve."

There are, however, certain criticisms to make against this pressure theory.

1. It is difficult to understand how the foetal head can press on the lumbosacral cord. This nerve lies tucked away in the angle between the sacral promontory and sacral wing, and when there is a discrepancy between the foetal head and the maternal pelvis, almost all the pressure must come on the sacral promontory and the pubic bones.

2. Were pressure the mechanism, one would expect the paralysis to occur on the side where the foetal occiput lay. In *Case 2* the foetal position was *left* occipito-anterior, but the paralysis was on the *right* side.

3. In a certain number of cases, towards the latter part of pregnancy, the patients complain of definite pains in the distribution of the sciatic nerve. These are not so common as cramps, but, nevertheless, do occur.

I believe that any mechanism which explains this rare post-partum paralysis should also explain the commoner ante-partum sciatic pains. Pressure clearly cannot be responsible for the latter, for if the head has already sunk into the pelvis there can be no pressure, and if not, there can be no pressure without active and painful contractions of the uterus.

In this connection there is an extremely interesting case published by Patel in the *Lyons Médical* of 1905 :—

Case 3.—A woman, age 25, had a normal first pregnancy and labour, but a certain amount of pelvis flattening was noted. The child weighed $5\frac{1}{2}$ lb. She nursed her child for fourteen months, at the end of which she was found again to be five months pregnant. At this time she suddenly felt violent pains in the whole of her right lower limb, and in a few days lost all power in it. After a week the pain subsided, but the paralysis persisted. Within three weeks from the onset the muscles recovered, except those supplied by the external popliteal nerve, which showed the reaction of degeneration. She was, however, able to get about.

The child was born at full term ; low forceps were applied after a 30 hours' labour. The child weighed $5\frac{3}{4}$ lb. The patient's leg felt lighter afterwards, but the foot-drop persisted. There were no sensory changes. Four months after the birth of the child she was again examined, and the condition was unchanged.

Patel considered this case to be one of mechanical neuritis, rather than of the infective or toxic variety, because there was no evidence of infection and there had been no vomiting or albuminuria. On the contrary, in spite of her disability the patient was able to get about, and, moreover, went to full term. It is difficult to believe, however, that the head of a five months' foetus could cause such great pressure on the lumbosacral cord.

Within the last month, Brooks read a paper on the sacro-iliac joint before the Guy's Hospital Anatomical Society. He had dissected about twenty pelves of patients who had died shortly after labour, though none of them was difficult. He concluded that during the first stages of labour there was a rotation backwards of the sacrum, the axis being through the lower half of the auricular facet, the excursion in some of these cases being as much as a quarter of an inch. Since this is a mechanism designed to enlarge the antero-posterior diameter of the pelvic inlet, it is not unreasonable to assume that in difficult labour the displacement would be even greater. On the other hand, the lumbosacral cord is known to be one of the tautest nerves in the body.

I would like to suggest, therefore, that the true mechanism of this condition is that of *traction* on the lumbosacral cord, and that the lesion is probably located in the roots of this nerve rather than along its course. This theory would account for both the ante-partum sciatic pains and the rare post-partum paralysis, for the loosening of the sacro-iliac joints, which permits the sacrum to rotate, occurs in the latter part of pregnancy.

Unfortunately, no post-partum demonstration of this lesion in the human being has been recorded, but certain observations in animals are interesting.

Matthews Duncan, in his work, *Researches into Obstetrics* (1868), described the changes that occur in the sacro-iliac joints of the cow. He points out that in this animal the pubic bones are consolidated, and therefore all the movements designed to enlarge the pelvic inlet can only occur in the sacro-iliac joints. He says: "The sacro-iliac ligaments increase not only in thickness but in length, and are thus made slack and yielding. . . . Further, the opposing bone surfaces of the joints are smooth and lubricated. The ilia thus become extensively movable on the sacrum (or vice versa) in an antero-posterior direction, the motion being analogous to flexion and extension in the limbs."

If there is an element of truth about the traction theory which I have suggested, one would expect the cow to be particularly liable to paralytic symptoms before or after parturition, because the movements at the sacro-iliae joints are so very marked and the relations of the lumbosacral cord are not dissimilar to those in man.

Fleming, in his work, *Veterinary Obstetrics* (1896), discusses ante-partum paralysis and says: "Paralysis of the posterior extremities is not rare in the cow, especially when near parturition. It generally occurs 6 to 10 or 20 days before labour. . . . Ordinarily it persists until parturition and then disappears.

"The cause is somewhat obscure, but is supposed to be due to compression or straining of the nerves and vessels of the posterior extremity by the heavy uterus. In five or six cases, there was found at post-mortem examination infiltration of the gluteal muscles and discoloration of their fibres. The spinal canal contained a large quantity of serum, and the membranes of the spinal cord were injected."

In discussing post-partum paralysis, he says that it is comparatively rare. It may follow parturition, especially after the birth of a large calf. "Some authorities think it is due to injury to the sacral and other nerves during difficult labour, the sciatic nerves being particularly liable to injury. Post-mortem examinations, however, only furnish negative evidence of this.

"On the other hand, in some cases the spinal cord has been found injured and its vessels congested, with blood-clots in the spinal canal."

These post-mortem reports appear to favour the view of traction on the roots of the lumbosacral cord, for how else could blood-clot and serum be accounted for in the spinal canal, in a peripheral nerve lesion which is so reasonably presumed to be traumatic? Unfortunately I have not yet been able to confirm them, but should opportunity arise, a lumbar puncture in a recent case would help to settle the point.

In conclusion, I should like to thank Mr. Laming Evans and Mr. Trethowan for their kind permission to quote their cases.

THE ANATOMICAL RELATIONS OF THE GASSERIAN (SEMILUNAR) GANGLION.

By R. D. LOCKHART, ABERDEEN.

ANATOMY text-books do not place the surgeon in full possession of the details essential to operative procedure upon this region, and in recent volumes of surgery, while the authors write from actual manipulative experience, the anatomical description and illustration are inadequate for those who have not previously attempted to "beard the ganglion in its den!"

The four-poster pituitary bed is canopied and securely side-draped by dura mater, and the pituitary body itself is slung in a hammock suspended from the periphery of the canopy, as can be seen in the coronal section through the sella (*Fig. 325*). Between the wall of the hammock and the side curtain is the cavernous sinus.

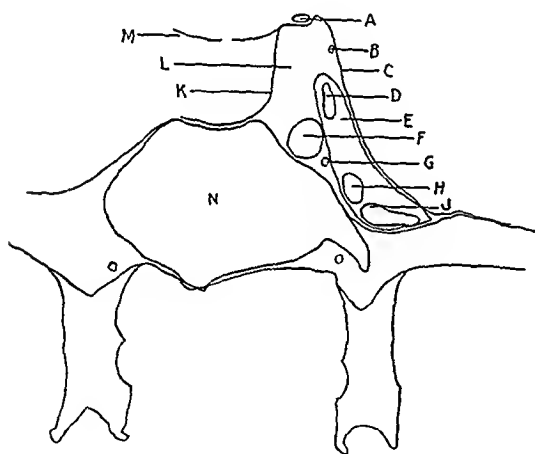


FIG. 325.—A, 3rd nerve; B, 4th nerve; C, Side curtain; D, First division of 5th nerve; E, Meckel's cave; F, Internal carotid artery; G, 6th nerve; H, Second division of 5th nerve; J, Third division of 5th nerve; K, Hammock; L, Cavernous sinus; M, Canopy; N, Sphenoidal sinus.

The tentorium cerebelli splits at the postero-superior border of the petrous bone, the upper layer becoming the dura mater of the midcranial fossa and also the side curtain, while the lower one covers the posterior aspect of the petrous bone. Where these layers separate along this border of the bone, the superior petrosal sinus runs to spread out like an estuary into the cavernous sinus, but just at the estuary the dura of the posterior aspect of the petrous bone is invaginated above the apex of the bone beneath

the superior petrosal sinus and beneath and medial to the side curtain. This invagination of dura mater goes by the name of Meckel's cave. Narrow at its entrance, where it transmits the roots of the fifth nerve, the cave widens to accommodate the ganglion with its branches; and a probe inserted along the lateral wall of the cave reaches forwards to the anterior wall of the pituitary fossa, laterally to the foramen ovale, and upwards, fully half the height of the cavernous sinus, without much resistance. While the lateral side of Meckel's pocket is easily freed from the ganglion and its branches, the medial wall is adherent, particularly to the first division and the anterior

part of the ganglion. Again, the lateral wall is fused with the side curtain, but these layers may be dissected apart (*Fig. 326*), and it must be remembered that they are separated posteriorly by the superior petrosal sinus.

Bearing in mind that fully the lower half of the lateral wall of the cavernous sinus is formed by three layers of dura mater, of which the outer two are fused, it is easily possible, by an intradural approach, to incise these two layers for exposure of the roots, ganglion, and branches, and this without tapping any venous sinus, provided the incision is not carried as far back as to enter the superior petrosal sinus, which actually separates the two layers near the neck of the cave.

In certain cases (*Fig. 327*) the cave reaches as high as and fuses with the canopy, and the sphenoparietal sinus tunnels back between the side curtain and the cave, to enter the cavernous sinus together with the superior petrosal sinus.

The present preference to cut the sensory root may render recognition of the motor root important in bilateral cases of trigeminal neuralgia. In addition to its identification by stimulation, it may be defined by its position superior and medial to the sensory root in the neck of the cave, and then running diagonally underneath the ganglion to the foramen ovale, although observers have seen it transmitted separately through a small foramen medial to that in question.

It has been stated¹ that the foramen spinosum with its middle meningeal artery frequently lies on a plane anterior to that of the foramen ovale, but the examination of 350 specimens has failed to find this variation.

When the floor of Meckel's cave is removed the bone is not bared but covered by the periosteal layer of the dura mater through which a branch of the middle meningeal artery supplies the ganglion, and the great superficial petrosal nerve runs beneath the ganglion to its pterygoid (Vidian) canal.

It will be noted that the third nerve has been purposely excluded from the cavernous sinus in the coronal section through the pituitary fossa (*Fig. 325*). Most text-books illustrate the nerve within the sinus in this area; but it begins to tunnel the dura mater at the level of the anterior clinoid process, and, in any case, does not enter the sinus until after it has dipped under this process, otherwise Horsley would not have injured

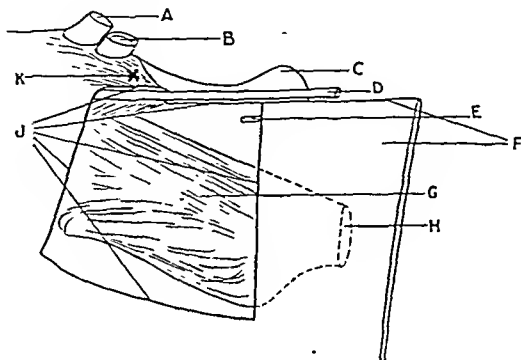


FIG. 326.—A, Optic nerve; B, Internal carotid artery; C, Dorsum sellæ; D, 3rd nerve; E, 4th nerve cut away in flap; F, Free margin and upper surface of tentorium cerebelli; G, Meekel's cave exposed from lateral aspect by removing flap; H, Entrance to cave; J, Cut edges of flap; K, Anterior clinoid process.

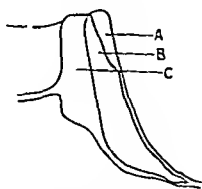


FIG. 327.—A, Sphenoparietal sinus; B, Meekel's cave; C, Cavernous sinus.

this structure in his operations upon the pituitary body by the temporal route.

Fig. 325, showing the structures resting upon the doorstep of the pituitary fossa, suggests the idea that, by burrowing under the dura mater of the mid-cranial fossa, the surgeon might break through this doorstep into the sphenoidal sinus, and gain the sellar floor from below in suitable pituitary cases. This would be a shorter route than any other. The bone is usually transparently thin; indeed, the doorstep and sellar floor have been seen formed by the sphenoidal sinus mucous membrane alone. Such a case as the one illustrated would lend itself to the production of trigeminal anæsthesia by painting the sphenoidal wall with cocaine.²

It is an interesting etiological consideration whether sphenoidal sinus conditions may not be associated with the lower position of the second and third divisions of the fifth nerve upon the doorstep and the occurrence of neuralgia in these very branches; and further, interesting to associate the fact that the sides of the sphenoidal sinus are seldom symmetrical with the fact that bilateral neuralgia is of infrequent occurrence.

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FACTS AND CONSIDERATIONS IN A STUDY OF THE THYROGLOSSAL TRACT.

By A. P. BERTWISTLE, LEEDS.

WITH AN ACCOUNT OF THE EMBRYOLOGICAL CONDITIONS.

By J. E. FRAZER, LONDON.

GROWTH AND DEVELOPMENT OF THE THYROGLOSSAL TRACT.

IN giving an account of the changes undergone by this outgrowth it will not be necessary to enter into the details of all the formations connected with it. It is a matter of common knowledge that there is such a growth, that it arises immediately behind the tuberculum impar, and that it is concerned ultimately in the formation of the isthmus and lateral lobes of the thyroid gland; but there are certain features and particulars in its development that are not so generally known or appreciated, and it is with these that I wish to deal in the present communication. It may be added, moreover, that, the median growth being the subject of this paper, the writer is only incidentally concerned with the formation of the lateral portions, and does not propose to enter on any further description of their development.

The median thyroid bud is a very early formation, becoming evident as soon as the mandibular arch is definitely present, and retaining its association with the entodermal lining of the primitive pharynx usually up to the time when the embryo measures some 7 or 8 mm. in length; but there appears to be some little variability in this matter. The section shown in *Fig. 328* illustrates this continuity in an embryo of 4.5 mm., and shows also the shortness of the outgrowth at this stage and the presence of a definite lumen in its proximal part. The section is very oblique, owing to the lateral flexion of the head of the specimen, but the small second viscerol arch can be recognized behind the outgrowth, while the hollow appearance in front of it, between it and the mandibular projection, is produced by the line of section here passing through the groove beside the tuberculum impar.

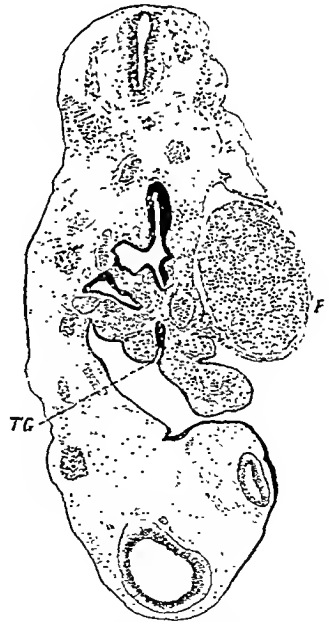


FIG. 328.—Section through the head of an embryo of 4.5 mm. TG, Thyroglossal outgrowth; P, Pericardium and left auricle, cut.

The obliquity also brings other things into evidence, however, and it is really to show these that the section has been taken. It can be seen that the pericardium (P) has been cut on one side, with the left auricle, and the aortic stem coming from this is cut across close to its division into right and left ventral aortæ. The thyroid bud is in relation with these, lying against the arterial trunk and just above the pericardium; this last relation would be more evident in a sagittal section. The relation of the outgrowth to the arterial trunk and pericardium is an early and important one, concerned in its subsequent displacement and secondary position. The bud, as soon as it grows in from the entoderm, comes against the place of division of the arterial trunk (which is at the time immediately below the site of its formation), and retains this relationship as long as it is free.

Fig. 329 shows a sagittal section through an embryo of 10 mm. The median outgrowth is seen in contact with the arterial stem and also with

the upper and front part of the pericardial wall, but its continuity with the entoderm is broken, although it has clearly not moved very far away from its place of origin. An important fact now presents itself. The bud and the arterial stem are lying in a mesodermal bed decidedly 'looser' in texture than the condensed masses which intervene between them and the pharyngeal cavity and form the visceral arches. This is seen in the section, and is also very apparent in the section shown in *Fig. 328*, and the fact is one of primary importance as

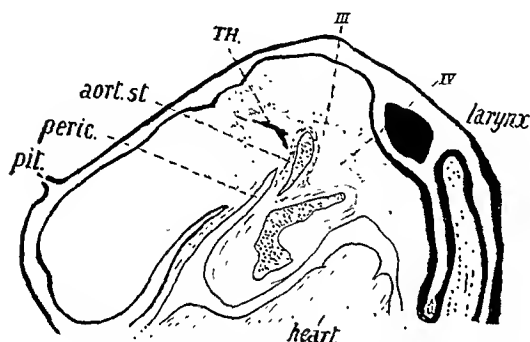


FIG. 329.—Median sagittal section, 10-mm. embryo. Reconstruction. TH, Thyroglossal growth; peric., Pericardial cavity; aort. st., Aortic stem; pit., Rathke's pouch; III, IV, general lines and positions of 3rd and 4th lateral pouches.

rendering possible the dislocation (with reference to the visceral arches) in a caudal direction of the structures lying in the looser lower bed of mesoderm. It is evident that an epithelial bud lying between condensed masses, such as the visceral arches, would remain in that situation, as it possesses no power of active movement other than that extension in area brought about by rapid multiplication of its cells; hence such a bud must pass beyond the constraining influence of the condensed masses, and enter an area where it is not subjected to so much pressure, and where, if its further development calls for change of position, this can come about through the action of some efficient agent. This is what has occurred in the case of the thyroid bud; growing in the middle line, with the mandibular condensation in front and the developing 2nd arch forming behind, it can only extend down between these condensations, and thus very soon reaches the plane of less condensed mesoderm which underlies the arch-masses, coming into relation here with the common arterial trunk where it divides.

The plane of looser mesoderm is no doubt a remnant of the original floor of the foregut. The new floor is made by the visceral arches, forming

immediately below the entoderm of the cavity, invading, in a sense, the floor-area from the sides. The old mesodermal layer remains associated with the roof of the perieardium, and the common arterial stem enters it from the perieardium and divides within it. The arterial arches enter the condensations of their corresponding viscerol arches, and are thus retained in position. The lateral pouches of the pharynx, projecting ventrally and laterally between the arch condensations, also come to lie on each side within this bed of looser mesoderm, ventrolateral to the pharyngeal cavity. It is of interest to note that the 3rd and 4th pouches, owing to the curve of the pharynx, are near one another, and not very far from the arterial stem, although, of course, they are placed more laterally; thus, in the 10-mm. embryo (*Fig. 329*) the general positions of these pouches might be indicated by the interrupted lines *III* and *IV*, and their nearness to the arterial stem, the thyroid rudiment, and the perieardium is evident.

Growth in length—and in other ways—of the pharynx is now proceeding apace. It is usually said that the perieardium and heart assume a more caudal position with reference to the pharynx, it being implied that this retrogression is primarily a shifting of the heart and its surroundings. This, however, is not the correct way of viewing the matter. The perieardium should be looked on as a fixed structure, being continuous with the septum transversum, which makes its caudal wall; it cannot shift caudally, and the description usually given is incorrect in so far as it implies such shifting.

Actually it is the excessive growth of the anterior end of the embryo which carries it beyond the stationary perieardium, curving round this at first as it is attached to its ventral surface, but gradually standing away from it as the attachments lengthen. So far as the neck is concerned, this growth forwards of the pharyngeal floor is rendered possible by the existence of the looser stratum between it and the perieardium, the hinder part of the floor moving up on the underlying structures. Thus the thyroid rudiment and the arterial stem retain their general relationship with the perieardium, and the pharyngeal pouches, moving up with the arch structures that make the floor of the pharynx, come into close relationship with them. This is seen in *Fig. 330*, a sagittal section in an embryo of 13.5 mm. The relative positions of the arterial stem, the thyroid rudiment, and the perieardium are practically as before, but the whole pharyngeal floor, greatly thickened, has moved up over them, and the thyroid growth has extended laterally and has come into relation with the 4th pouch, the general position of which at this stage is indicated by the interrupted line *IV*.

This, then, is the way in which the change in level comes about; but

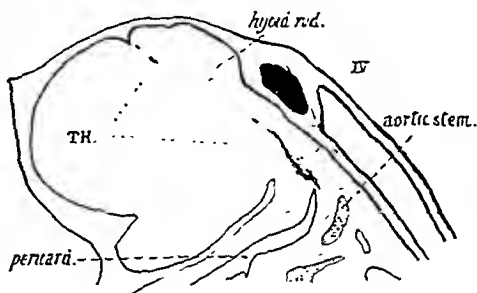


FIG. 330.—Median sagittal section, 13.5-mm. embryo. Reconstruction. TH, Remnants of thyroglossal tract, the line of which is ventral to the hyoid rudiment. IV, General line of the 4th lateral pouch.

before passing to the consideration of the extension of the outgrowth it will be convenient to deal with one or two other matters which are evident on examination of the sections already shown. It is clear, as can be seen in *Fig. 329*, that the outgrowth reaches the deeper loose layer by passing between the condensations of the 1st and 2nd arches, and its subsequent position is on the ventral side of the 2nd arch; as the pharynx grows, the 2nd and succeeding arches are moved forward over the thyroid rudiment. The pharyngeal growth has already progressed to a slight extent in the 10-mm. specimen, and the thyroid rudiment, apparently as a consequence, is separated from the entoderm; this matter will be referred to later. The skeletal bars of the 2nd and 3rd arches, the constituent parts of the hyoid bone, are formed in the mesodermal condensations of these arches. They are not in any way evident before, or for a considerable time after, the rudiment has separated from the entoderm, but, although on this account the direct demonstration cannot be given, it seems to me to be quite clear that the track of the growth

is, and must be from the beginning, *ventral* to the hyoid structures. At 12 mm. the condensations of the skeletal bars are evident, and their situation in the middle line (3rd arch) is indicated in the 13.5-mm. specimen in *Fig. 330*. The relation to the arterial stem and pericardium is not one of absolute contact, suggesting that the relation is maintained, after its attainment, because there is no force acting on the rudiment in such a way as to displace it.

Turning now to the growth itself, its appearance from the front in each of the three stages chosen is given in *Fig. 331*. The bilobed state of the first stage becomes changed into the nearly symmetrical broad shield of the second.

which ends below in a blunt median point near the pericardium. The shield is extending on each side along the arterial trunks. In the 13.5-mm. specimen the extension along the arteries has brought the growth into relation with the 4th pouch, to which it seems to be definitely attached. This attachment, then, may be taken as an agent anchoring the growth on each side. In the middle it may be presumed that the original relationship with the central vessel and pericardium persisted until the attached lateral portions interfered with it; hence we find the central portion lower than the rest, still with a central stem running into its upper part and a blunt point below, near the pericardium, but the face of the original shield is changed by the proliferations it has undergone.

Fig. 332 is a schematized reconstruction showing the whole extent of the thyroglossal tract in an embryo of 18 mm.; in this, for the first time, the upper stem of the 'shield' is found lying on one side. The curve of the extended growth is much closer than before, the arterial division is further

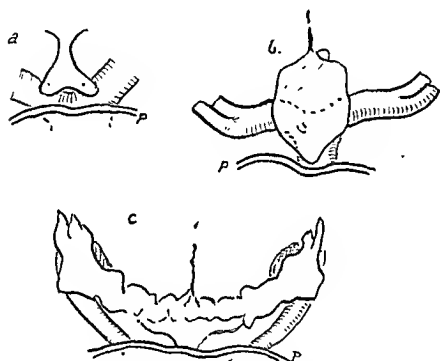


FIG. 331.—Thyroid growths seen from the front. Reconstructions. Embryos of (a) 4.5 mm., (b) 10 mm., and (c) 13.5 mm. The relation of the growth to the arterial trunk is shown, and to the roof of the pericardium, P.

away, as is also the pericardium, and there is no definite indication of the blunt-pointed lower end.

Proceeding now to the consideration of some of the details brought out in these figures, we may turn first to that part of the tract lying above the hyoid bone. This seems to disappear almost entirely in the earlier stages, after the separation from the entoderm, but I am inclined to think that the cells of this part of the tract, though it is almost certainly broken up, are not really lost. My chief reasons for this belief are: (1) There is no sign of degeneration or destruction in the cells of the tract whenever they can be definitely found, although their staining reactions are very slight or absent; (2) The position of the tract can be followed without very much trouble, and groups of cells can be found in it here and there, which may be, and in my opinion probably are, remnants of the tract; and (3) That in somewhat later stages darkly-staining cells like the other cells of the tract are found in its line. Such definite remains are seen in *Fig. 330*, and a very complete and undoubted tract in *Fig. 332*. The remnants—that is, the formations that seem to me to be remnants—are few and scattered. They appear to be most often found near the upper end of the track of the outgrowth, but sometimes one sees them just in front of the body of the hyoid. These situations are what might be expected, and I believe that the remnants are usually few and scattered, as there is much individual variation in my specimens of the second and third months. The 18-mm. embryo (*Fig. 332*) is the only one that I possess showing a continuous tract reaching the hyoid, but that such rare tracts are found after birth is shown by such cases as that of C. F. Marshall (*Jour. of Anat. and Physiol.*, 1891).

The tract below the level of the hyoid is present in all my specimens of the second and third month, in the middle line, or, more commonly, to one side or the other; it can usually be picked up just above the lower border of the hyoid bone and followed down from this point. I have also found it in nearly all the fetuses that I have examined from this point of view, and it is of interest to note that Marshall (*Jour. of Anat. and Physiol.*, 1895), in 60 children aged from a few weeks up to 10 years, found it (pyramidal process) in 43 per cent. This part of the tract consists of the unpaired and originally central stem, and the isthmus and lobes: of these the stem and isthmus are the portions of more immediate interest in this place. These are the remains of the earlier 'shield' after its lateral prolongations along the arteries have reached the lateral pouches. When this stage is reached the stem begins to show some indications of proliferation, and of breaking (*Figs. 331 and 332*), but much more definite signs of proliferation are found in the isthmus. The columns and masses of cells formed in the central isthmus move in great part to the lateral

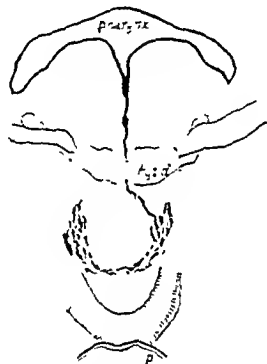


FIG. 332.—Reconstruction of the line of the thyroglossal tract in an embryo of 18 mm., showing an unusually complete suprahyoid portion, and the obliquity of the lower tract, produced by the migration of the proliferating cell-masses of the central (isthmus) region, with which it is continuous, to join the lateral mass of one side.

lobes, and form parts of these, and in this way, the frequent obliquity of the pyramidal lobe, or stem, is probably brought about; the result on the really central stem of such growth is shown in an extreme degree in *Fig. 332*. Looked at in this way the position of the stem in any individual case might be said to be accidental, and we have an explanation at once of the inequalities of the isthmus, its great size in association with a median pyramidal lobe, its absence with a pyramidal process attached to one lateral lobe, the bifurcation of the lower end of the pyramid with attachment to both lateral lobes, and in fact of all the varieties figured by Marshall. The stem may remain as a complete pyramid, or it may be broken; some of the sections show it clearly broken, especially in its upper part. The cells thus left in position are demonstrably capable of the staining reactions exhibited by the continuous parts, and one might be justified in looking on them as potential thyroid fragments which might conceivably (as, for instance, if the rest of the thyroid tract were not functioning adequately) take on further development as part of the thyroid structure. Such groups of cells might well be expected more especially near the hyoid bone, but, in the absence of a pyramidal lobe, might occur anywhere in the line which it had occupied before it broke up and apparently disappeared.

It is not possible to make any decided statements about the blunt-pointed lower end of the shield of earlier stages. It is to be recognized in embryos of 15 and 16 mm., but not in any of the later specimens. There are small veins forming a plexus round this part of the growth, however, and it seems to me not improbable that proliferating cells may extend along these, thus reaching the innominate veins and even the pericardium, but such cells have not been recognized definitely. In the 16-mm. specimen there are some projections downwards from this region on one side, and there is a suggestion of cells coming off these and applying themselves to the thymic rudiment. Thyroid formations do occur in the upper thorax, and the means by which they find their way to this region may be as indicated above, but I am not at present able to produce clear evidence on the matter.

A couple of points still remain for consideration, the first of which has to do with the relation of the tract to the hyoid bone. This relation I hold to be primarily *ventral*. I have already spoken of the relation the tract must necessarily bear to the condensations of the arches if these are to be free to move forward over it, and it is only necessary to understand that the skeletal elements are formed in these condensations to see the necessary relationship. It is unfortunate that, in the human embryo, the tract is broken before the hyoid rudiments are recognizable, but a glance at the reconstructions given will show the relation. Moreover, sometimes the indications are more definite, and I have before me now the photograph of a sagittal section through the region in a 12-mm. embryo in which there does not seem to be any doubt whatever of the ventral position of the tract. I may add that *His* and, I think, most embryologists of to-day have this opinion on the matter, and that I reached it independently years ago as the result of direct observation. Such cases as Marshall's (1891), in which he described the remnant as passing up to the tongue dorsal to the hyoid arch, I am convinced, founded on errors

of observation, and in that case he describes and figures the supposed continuity as broken and incomplete. The very few opportunities one has had of dissecting the condition in the adult have borne out completely the findings in the embryo and foetus. The retrohyoid part of the tract—which is usually present—has been carried into this situation by folding round the lower edge of the bone;

FIG. 333.—Diagram to show relation of a complete infrahyoid tract (T) to the hyoid bone. Beginning in front of the bone, it bends backwards round its lower border, and turns up behind it for a little distance before passing down. This is a secondary turn, produced during the third month from the earlier and purely ventral condition.



the complete tract would be as represented in the scheme in *Fig. 333*. but it may be broken in various ways.

This disposition seems to come about in the third month, and is associated with the general settling down into place of the structures in the neck as this reaches its final stages. One has seen the tract where it lies near the side of the body of the bone partly enclosed by bony growth round it, but careful dissection showed the true nature of the condition and exhibited a complete folding such as that in the scheme. Such a condition might perhaps lead to the description of a tract passing through the bone, for which otherwise no justification is apparent. The relation of the tract to the cartilaginous hyoid body in the third month is of interest, for it is closely related to it, embedded almost in the perichondrium of its lower and front part; this may account for its occupying a notch on the bone, and, if one may venture on a surgical matter, it may point to the advisability of removing the periosteum in the effort to excise the area of the tract.

The second point has to do with the foramen cæcum. This, although it gives the situation *on the surface* of the spot from which the thyroid growth arose at one time, is not really the remnant of that spot at all. In the third month certain posterolateral growths form the hinder part of the tongue. It is not necessary to enter into an account of these, and it is sufficient to say that, growing on to and over the corresponding aspect of the tongue, they meet in the middle line behind, and extend outwards and forwards on each side from this. The angle of their divergence makes the foramen cæcum, the angle being situated over the site of the thyroid growth. The two parts, meeting just behind this, fuse together, but in doing so they enclose a space deeply between them. A section made horizontally through the tongue in an embryo of 35 mm. is given in *Fig. 334*, showing the meeting of these two portions of the tongue over a cavity, from the floor of which, but at a lower level than that of the section, the epithelial projection that marks the old thyroid tract is to be found; the cavity is evidently a secondary one, superficial to the old surface, and is lined by epithelium of the surface. This cavity appears to dwindle in size quickly; it is a small recess in a specimen about 38 mm., with its lining membrane reduced to a double layer of cells, and it apparently disappears shortly after this. It is not impossible, however, that the cavity, like others made by enclosure, may persist. Certainly a depression some $\frac{1}{4}$ in. or more in depth can be found every now and then

below the foramen cæcum, and it was probably an extensive persistence of this cavity, extending back on each side towards the lateral epiglottic regions, that Heister described in 1750 as a new system of 'salivary ducts'. If the cavity persists, it opens on the surface at the foramen cæcum, and thus the thyroid tract, running from its floor, comes to 'open' indirectly at this foramen. If persisting and closed, on the other hand, it will be superficially separated from the mucous membrane only by a thin layer of submucous tissue.

It has seemed to me quite possible that this may be the origin of some of the so-called thyroglossal cysts placed superficially on the hinder part of

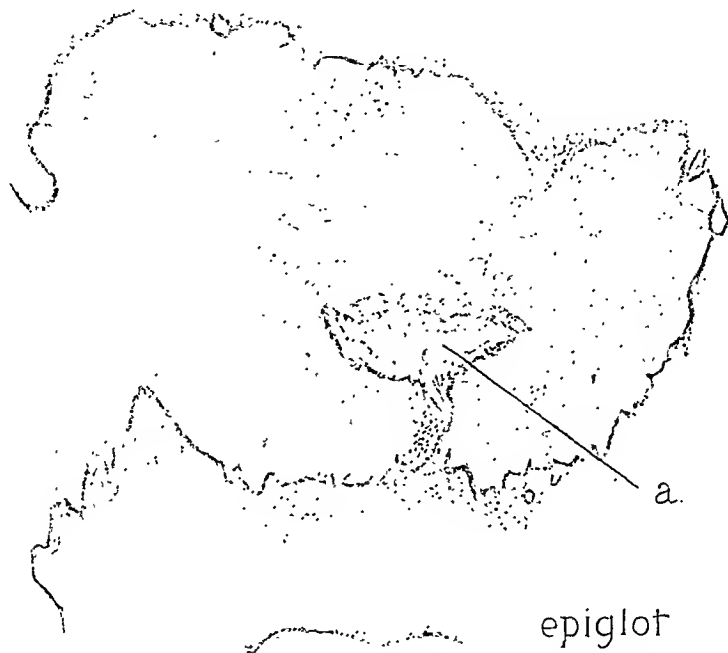


FIG. 334.—Horizontal section through upper and back part of the tongue of an embryo of 35 mm., to show the secondary cavity (a) enclosed by the meeting of the posterior tongue-growths in the middle line.

the tongue; if this were proved to be so, they would be vestigial retention cysts with no thyroid or thyroglossal character, unless indeed there were concomitant activity in a thyroglossal stalk-remnant attached to the lower wall of the cyst. *Case 10* of this series seems possibly a vestigial retention cyst of such a sort.

Summing up from a clinical or pathological point of view the main facts dealt with in this account, we may say that:—

1. The thyroglossal remnants above the hyoid are few, and if present are usually either near the foramen or near the hyoid.

2. Below the hyoid the tract is present completely in many cases, incompletely, i.e., potentially, in others.

3. The complete infrahyoid tract extends from the hyoid, usually folded up behind it from below, to the thyroid gland, either centrally or on one side.

4. The incomplete tract has *potentially* exactly the same line; it is the tract simply broken up, and its parts remain *in situ*.

5. Any of these remnants may take on further development, especially perhaps if a condition of relative hypothyroidism exists.

6. It is possible that some cells of the tract may be separated off and lodged below the level of the gland; if this is so, these cells may also be liable to take on further development. It may be pointed out here that certain continental embryologists, some thirty to forty years ago, maintained that the median fistulæ, etc., found low down in the neck, arose from remnants of the precervical sinus, a view strongly supported by Kanthack in this country. This view would not receive extensive support from embryologists to-day, and may be passed by.

7. Cysts lying superficially below and behind the foramen cæcum may have a possible origin from a space included between the two halves of the developing hinder part of the tongue, and not necessarily be connected at all with the thyroglossal tract.

It may be added, finally, that any appearance of a potential 'duct', judging from the arrangement of cells, seems to be confined to the suprahyoid portion. The lower stem, although it appears to be but a separated part of the 'duct', does not show a tendency to arrange its cells in a similar way. When it enlarges it proliferates like the lower structures, and, when broken, the separated cell groups may be presumed to have the same tendency. Hence it seems to me that such a thing as a dilated duct, or fistula from such a remnant—if it occurs at all—would be above the hyoid, but that in most cases, those which occur below the hyoid, the first formation would be in the shape of a thyroid growth with development of the usual thyroid cysts or vesicles, and any secondary fistula would open into such a cyst. Though the possibility of the other formation cannot be denied, these appear to be the rational inferences from what I have observed of the development, and my small experience of the pathological conditions seems, so far as it goes, to support this view. [J. E. F.]

CLINICAL CONSIDERATIONS.

The unsatisfactory results of operations performed on the cysts and fistulæ of the thyroglossal tract are well known. Some of the factors leading to these results are discussed above, especially the anatomical relations of the thyroglossal tract to the hyoid bone. The increased discharge from the fistulæ which occurs during the ingestion of food raises the question as to whether the thyroid gland and its congeners become more active during the process of digestion. Only eleven cases are described, but as they illustrate most of the points which have been discussed, it is felt that their publication is justified. They have all been personally investigated, with the exception of *Case 10*, the details of which were kindly supplied by Dr. Vining.

FISTULÆ.

*Case 1 (Figs. 335 and 336).—*A woman, age 28, was admitted with a small translucent nodule in the neck, exuding a thin serous fluid. She states this secretion was increased during mastication. According to her account, it had existed about six years, during which time it had occasionally ceased discharging. A swelling then appeared. This burst, and the immediate discharge was a thick, yellow fluid. On puncturing for injection purposes a honey-like fluid escaped.



FIG. 335.—*Case 1.* Photograph of sinus.

MICROSCOPIC EXAMINATION.—An open tract runs along the length of this specimen, lined by very vascular and thick granulation tissue. No epithelial lining cells are to be seen anywhere. A fairly thick mass of thyroid tissue, with well-developed vesicles, extends along the whole length of the tract, but only along one side of it (? which side). Every stage of formation of the vesicles is to be found in the sections of this aspect of the tract.



FIG. 336.—*Case 1.* Radiograph showing pear-shaped bead of bismuth paste.

Case 2 (Fig. 337).—“Occurred in a boy aged 7. The sinus was first noticed when he was 18 months old, and has since remained stationary. At times a swelling appeared, and then he had pain during mastication, otherwise there was no inconvenience except from a thin discharge, occasionally replaced by a sticky yellow fluid. The sinus was present in the mid-line of the neck, surrounded by cicatrices. It moved on deglutition, and was palpable as a firm cord attached to the hyoid bone.

“‘B.I.P.P.’ was introduced into the sinus by means of a large bone syringe. The opaque material is seen passing up towards the hyoid bone in the radiogram.”

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OPERATION.—The sinus was found to end in a fibrous cord which passed into the median raphe above the hyoid bone. Three months later the sinus was still present, but the discharge less copious; a keloid had developed.

MICROSCOPIC EXAMINATION.—Sections taken throughout the growth show that it consists mainly of thick fibrous tissue, arranged in bundles. Pockets and strata of somewhat embryonic-looking tissue lie between and among these bundles, and in these occur clumps of large and darkly-staining cells, which here and there form small cysts or groups of two or three cysts: in some instances there seems to be colloid in such. The large cells in the pockets seem to have a tendency to arrange themselves circularly, and the appearances are reminiscent of embryonic thyroid formation. No duct or surface is to be found in the specimen.

Case 3.—This was a girl of 4, and the ulcer first appeared a few months after birth. There was constant discharge, except on the rare occasions when it healed over, only to break down again. Several attempts had been made to deal with it.

OPERATION.—A similar operation was performed to that of *Case 1*. The wound, however, broke down; four months later the discharge was as copious as ever, and a slight keloid was present.

MICROSCOPIC EXAMINATION.—The specimen is rather fragmentary, but there seems to be a cavity or duct within it, with walls of granulation tissue, but showing in places an epithelial lining. This is of single cells in part, but becomes stratified in other parts, and has the appearance of invading the underlying tissue, having in fact a suggestion of malignancy here and there. The surrounding tissue is composed of bundles of fibrous appearance. No structures that can be recognized as probably thyroid in nature can be found in the intervals between the bundles, where there are small masses of darkly-staining cells of somewhat embryonic sort; these masses appear to be continuous in places with the epithelial lining of the sinus. A few muscle bundles are present.



FIG. 337.—*Case 2.* Radiograph of sinus injected with 'B.I.P.P.' Observe relation to hyoid bone.

CYSTS.

Case 4 (Fig. 338).—A woman, age 29. The swelling of the neck which had existed for some time had lately increased in size, and become tender, interfering somewhat with mastication.

OPERATION.—A transverse incision was made along the line of the natural crease in the neck. The cyst was freed as much as possible, not, however, without the contents escaping. The fluid in the cyst resembled pus; some was collected for chemical examination, and found to contain iodine. The whole of the cyst wall was carefully removed, and the wound closed by intradermal suture. There was no return of the cyst after four months.

MICROSCOPIC EXAMINATION.—One slide. A section showing thick granulation tissue round what may have been a sinus or cavity; outside this are bands and

bundles of fibrous tissue, with material of embryonic type between the bundles. A tendency to formation of thyroid structures is found here, with some groups of definite and fair-sized vesicles.



FIG. 338.—Case 4. Note prominence in neck due to cyst.

*Case 5 (Figs. 339 and 340).—*A girl, age 12, was admitted on account of a swelling in the neck that somewhat obscured the hyoid bone. It was tender and rapidly increasing in size. The cyst was aspirated preliminary to the injection of collargol. This had for its purpose the demonstration of the cyst's extent radiographically, and the destruction of any bacteria present. The contents were like pus. Unfortunately the swab taken was lost, and no bacteriological report

was obtained. Chemical analysis showed the absence of iodine. After the injection she became faint, and operation was delayed until next morning.

OPERATION.—A transverse incision was made along the natural crease of the neck. All the tissues were found to be sooty black in colour. Extreme difficulty was experienced in dissecting the cyst from behind the hyoid bone. A subcuticular suture completed the operation. The following day a black discoloration was apparent in the neck. Later a temperature of 101° developed, and a few days afterwards the wound broke down, gaping one inch. The pigmentation had spread over the adjacent part of the face, and 5 c.c. of antistreptococcal vaccine were injected. A week later it was beginning to fade, but the wound was unhealthy and its surroundings were brawny. At the end of six weeks the wound had almost healed, but the tissues in the vicinity were still indurated. Four months after operation there had been no return, and the scar, although adherent to deep structures, was surprisingly inconspicuous, being situated in the natural crease of the neck. The pigmentation disappeared about the third week.



FIG. 339.—Case 5. Showing prominence in neck.

MICROSCOPIC EXAMINATION.—Mainly a mass of fibrous tissue, with collections of large cells with darkly-staining nuclei between the fibrous bundles. No tendency

to vesicular formation is to be seen in these cell-groups for the most part. but such is to be found. however, here and there near the walls of a cavity occupying one side of the specimen. This cavity is irregular, with ragged walls of apparently necrotic tissue. surrounded by much infiltrated substance. There is no sign of brown injection in this cavity, but this is to be found in a couple of recesses—whose connection with the larger cavity was not discovered—and the walls of these recesses are composed of fibrous tissue without any signs of small-cell infiltration.

Case 6.—A girl of 14 had a cyst in the middle line of the neck adherent above to the hyoid bone. It was causing some disfigurement. and had recently increased in size.

OPERATION.—A vertical incision was made, and the cyst removed. It was adherent below to the thyroid gland. One month later there was a recurrence. A long red sear was visible, which it would be difficult to hide by any



FIG. 340.—*Case 5.* Cyst filled with collargol.

means, natural or artificial.

Case 7.—A girl of 6 had a tumour in the usual position.

OPERATION.—The cyst was removed through a transverse incision. It recurred within three weeks.

Case 8 (Figs. 341 and 342).—A man, age 28. He complained that the swelling in the neck was increasing in size. It interfered with deglutition, slipping up behind his collar during the act of swallowing. He had 'neurasthenia' one year ago.

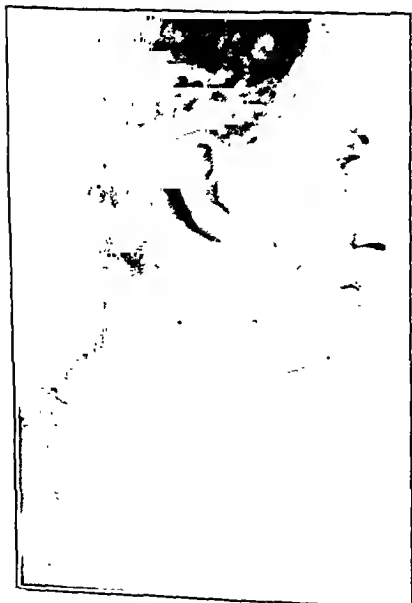


FIG. 341.—*Case 8.* Note prominence in neck.

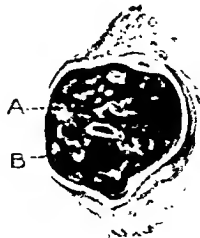


FIG. 342.—*Case 8.* Cyst excised. Note colloid among the blood. A, Colloid; B, Blood. (Natural size.)

At the time of the operation there was no sign of exophthalmic goitre.

OPERATION.—Under local anaesthesia a transverse incision was made over the lowest part of the tumour, so that the subsequent scar should be out of sight. The



FIG. 343.—Case 9. Observe cyst in neck.

was no return in three months, and no keloid had developed.

Case 10 (Fig. 344).—A wasted baby of 5 weeks was admitted on account of difficulty in swallowing. In hospital he had several attacks of dyspnoea, one of which ended fatally five days after admission.

POST-MORTEM EXAMINATION.—A cyst was found at the foramen caecum of the tongue. There was some oedema of the glottis, and one lung was in a condition of indurated pneumonia.

MICROSCOPIC EXAMINATION.—One sagittal section through the back of the tongue, epiglottis, and part of the larynx. A large cyst in the hinder part of the tongue. It has an epithelial lining, for the most part of single cells, but occasionally this kind is replaced by flattened cells in two or more layers; in one or two places an appearance of several layers, but this may be due to obliquity of section. No colloid or other contents of the cyst are to be found, a

tumour was connected with the hyoid bone by a thin fibrous band, and to the isthmus of the thyroid gland by a broader band of a similar nature. It was easily removed, and a subcuticular suture finished the operation. The cyst when cut across was found to consist of a firm capsule containing a mixture of translucent colloid and blood. The blood probably resulted from pressure by the collar, and may explain its rapid increase. Chemical examination demonstrated the presence of iodine. Two months later the scar was barely visible, and there was no recurrence of the cyst.

Case 9 (Fig. 343).—A boy, age 2. A small superficial cyst was present between the thyroid cartilage and hyoid bone. It was noticed three months ago.

OPERATION.—A transverse incision was made and the cyst removed. It was adherent above to the thyroid cartilage. There

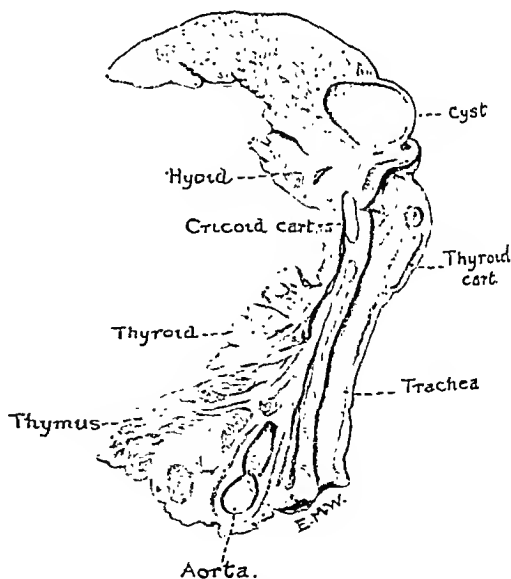


FIG. 344.—Case 10. Tongue and larynx showing cyst. Post-mortem specimen. (Natural size.)

fluid having probably escaped after hardening. A loose, thin, fibrous wall surrounds the cyst. This is compressed on its upper surface, as is also the submucous layer here, so that the cyst is only separated from the surface by a very thin wall. Groups of glands lie in front of the cyst, below the submucous layer, but none is to be found between it and the surface. No thyroid formation, or prolongation of cells from it in a downward direction, is to be seen, but the section is probably not a median one.

ADENOMA.

Case 11.—A child of 14 months had a small swelling in the neck, about the level of the hyoid bone, which was increasing in size. There were no symptoms.

OPERATION.—A transverse incision exposed two small pea-like bodies 3 mm. in diameter, resting on the mylohyoid just above the hyoid bone, one on each side of the raphé. In removing the first a relatively large artery was cut, and it was decided to leave the second one, lest it should prove to be the only functioning thyroid. On section the excised tumour proved to be solid: its character was determined by microscopic examination. Subsequent progress uneventful.

MICROSCOPICAL EXAMINATION.—A typical adenoma was found.

DIFFERENTIAL DIAGNOSIS.

The position of these cysts and fistulae and their movement on swallowing are so definite that their diagnosis is comparatively easy. The following conditions, however, give rise to some confusion:—

1. Suprahyoid lymph-glands situated on the mylohyoid, as seen in the pea-like bodies of *Case 11*; especially if these suppurate or become tuberculous.
2. Sequestration dermoids have been reported here, as elsewhere, in the mid-line of the body.
3. The infrahyoid bursa. This is rarely the seat of pathological processes.

OPERATIVE RESULTS.

Undoubtedly, incomplete removal is the most common cause of failure, but the inexact knowledge of the thyroglossal tract and its relationship to the hyoid bone account for some of the poor results of operation. It has been observed behind, in front, and in some cases passing through a foramen in the bone, and many cases are recorded where a cure was effected only after resection of the middle portion of the bone. This led to the supposition that the tract originally passed deep to the hyoid bone in its course from the tongue to the neck. From embryological findings this is not possible. *Fig. 337* shows the sinus to be running upwards to the anterior surface of the hyoid bone. Resection of part of this bone need not therefore be a routine procedure, it being possible to dissect it out from behind the hyoid bone as was done in *Case 5*. Another reason for unsatisfactory results is that the fistulae always become infected, and frequently attention is first drawn to the cysts when suppuration sets in, and they become tender. Again, cells of an embryonic character, but of varying types, are met with lining the cysts or fistulae, adenomata being rarely met with. The nature of the cell-lining may possibly influence the result. Columnar-ciliated and squamous cells are all found, and are probably sequestered from the buccal cavity. The impression given by microscopic examination of these cases points to the general existence of

rudimentary thyroid structure lying embedded in fibrous tissue tending to form vesicles by the cavities running together (J. E. F.). This would be instrumental in the causation of recurrences. It is curious that, in spite of the situation of the epithelium, and the number of cases recorded, we have been unable to find in the literature an example of carcinoma arising in the tract. The type of cell found would be of interest.

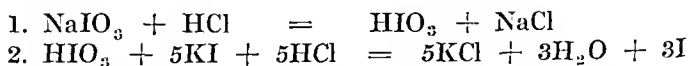
At operation a horizontal incision in the line of the natural crease of the skin of the neck should be adopted whenever possible. By this means the resulting scar is practically hidden, and as the operation—especially in females—is often done for cosmetic reasons, this is of real importance. This becomes very obvious when *Case 5* is compared with *Case 6*.

There is no record of the employment of X rays in the treatment of these cases, but it is suggested that a suitable dose before and after operation might prevent recurrence by killing off any bacteria, and possibly inhibiting the growth of the cells.

THE SECRETION OF THE THYROID GLAND.

In *Case 1* it was seen that the discharge from the sinus was increased during the active period of digestion; this fact had already been noted by several observers. Thus Spencer² states that “if the cyst is simply punctured, or incompletely removed, a sinus persists, which discharges mucus as the patient swallows, although there is no connection with the mouth or pharynx”. The explanation is still to seek; it may be simply mechanical, or of great significance. The acts of mastication and deglutition may cause the expression of a larger amount of fluid already contained in the sinus, or it may point to the possibility that the sinus is itself a secreting organ, functioning in sympathy with the other organs concerned in digestion.

An attempt was made to find a simple method of testing for the presence of iodine in the contents of the cysts on the lines laid down by Andrew Hunter.³ The principle involved was the conversion of all iodine in organic combination into iodate by incinerating with an alkaline fusion mixture. Free iodine was liberated from the iodate by the addition of excess hydrochloric acid and potassium iodide, and its presence shown by the blue colour with starch. The reactions are:—



A fusion mixture of potassium and sodium carbonates and potassium nitrate was prepared. The contents of the cyst were evaporated and powdered. One grm. of the powder was mixed with 20 grm. fusion mixture and placed in a nickel crucible, when the whole was heated strongly. At first it charred, then ignited, finally turning white. The residue was lixiviated with water; enough 10 per cent hydrochloric acid was added to neutralize the carbonates and leave an acid solution, and with it 1 c.c. of 10 per cent potassium iodide. A drop of 10 per cent starch was added, a blue colour indicating the presence of iodine. A quantitative estimation carried out exactly as described by A. Hunter would have given better information, as control experiments showed the presence of iodine in other tissues. McCarrison⁴ has found iodine in most

tissues, but whereas it never exceeds 0.001 per cent elsewhere, its minimum in the healthy thyroid is 0.01 per cent. No other tissue can fix iodine in organic combination.

The staining reaction of the contents of the cysts and the naked-eye appearance of the cyst in *Case 8* point to their containing thyroid secretion. McCarrison has shown that "the staining capacity of the colloid varies with the phase of activity of the gland. Fresh secretion stains feebly, old collections readily, varying in direct proportion to its iodine content".

The intimate association of the thyroid gland with the digestive tract is well known. A most important observation is that of Kendall:⁵ "The administration of thyroid hormone appears to have no direct action on the pulse. If amino-acids are injected simultaneously, the pulse-rate is enormously affected, and even death may result from the very great metabolism going on in the animal. It appears very probable that the thyroid's hormone manifests its activity in some way with amino-acids", i.e., with protein ingestion.

Diseased conditions of the intestines are reflected in pathological changes in the thyroid, and vice versa. Thus McCarrison states: "Intestinal stasis may be due primarily to subthyroidism, and this is especially the case where the thyroid defect is congenital or acquired in early life. If due to other causes, the stasis, once established, may lead to subthyroidism by the action of the gland on the production of bacterial growth in the static bowel, or the abnormal process of digestion may interfere with the efficient elaboration of the thyroid secretion, thus reducing the physiological activity. Thus a vicious circle is set up". The same author has shown that it is affections of the upper intestinal tract which are responsible for pathological changes in the thyroid. "A condition of hypo-acidity of the gastric contents is the rule in exophthalmic goitre, and this is, in itself, favourable to the infection of the upper part of the alimentary tract by micro-organisms of disease. The frequency with which such disorders of the tract precede the onset of Graves' disease is becoming increasingly evident. Dilatation of the stomach is frequent, as is an onset with vomiting and diarrhoea". Simple goitre has been proved fairly conclusively to be due to faecal contamination of food or water (McCarrison).

The successful use of intestinal antiseptics was suggested to McCarrison "by the fact that in certain animals (e.g., amphioxus) the thyroid is connected with the upper end of the intestinal canal by a duct, and probably exercises a destructive action on bacteria entering the tube". It is an undoubted fact that thyroid medication by the mouth is much more satisfactory than that of any of the other ductless glands.

Carlson, Dooks, and McKie find that the exhibition of toxic doses of thyroid substance in animals causes gastro-enteritis and diarrhoea.

It has been shown that parathyroids also play a part in digestion, in that they neutralize guanidine, a substance formed during purin metabolism.⁶ If injected in large doses, guanidine is capable of causing the nervous syndrome-complex of tetany in normal animals. The serum of dogs from which the thyroid has been removed acts upon the muscles of the frog similarly to weak solutions of guanidine.

An interesting observation is that "in exophthalmic goitre, where the gland is greatly stimulated, the activity of the salivary glands is usually increased, and salivation may be paroxysmal".⁴

Giordana and Caylor are uncertain whether or not the involution changes following ligation of the thyroid vessels in exophthalmic goitre are attributable to the lessened blood-supply or to the division of the sympathetic nerves accompanying these vessels.

The main points arising out of these facts give rise to the suggestion that possibly both the sinus and the main thyroid have an innervation identical with that of the salivary glands, the whole acting in sympathy. If this should prove true, new paths for research are opened up in the consideration of the treatment, medical and surgical, of affections of the thyroid, e.g., exophthalmic goitre. Different foodstuffs may have different effects on the thyroid, as Pavlov⁷ has shown in the case of the salivary glands. Instead of ligaturing arteries, attention may possibly be more usefully paid to the peri-arterial nerve plexus.

SUMMARY.

1. Division of the hyoid is rarely necessary if the dissection is carried up well behind the bone.

2. A horizontal incision, if possible, along a natural crease of the neck gives the best results as regards the subsequent scar.

3. A suggestion is put forward that the thyroglossal fistula is in direct anatomical relation with the thyroid gland, and that, *pari passu* with that of the salivary glands, its activity is increased during digestion.

Thanks are due to the honorary surgeons of the General Infirmary at Leeds for permission to use their cases. For the radiograms I am indebted to the X-ray department at Leeds, and for *Figs. 342 and 344* to Miss F. M. Wright.

[A. P. B.]

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THYROGLOSSAL CYSTS AND FISTULÆ.

By HAMILTON BAILEY, London.

THE gifts of embryology to surgery are manifold. The thyroglossal tract, not the least of these, was certainly one of the first to be generally appreciated.

For this paper it was considered advisable to adhere strictly to the surgical aspects of thyroglossal cysts and fistulæ, and 117 cases have been collected from the records of the London Hospital for this purpose. Whilst in hospital surgical practice thyroglossal cysts are frequently encountered, the actual incidence in the general population is probably exceedingly small, for in 86,000 consecutive patients examined in the Mayo Clinic only 31 cases of thyroglossal cysts were found (Sistrunk). In common with affections of the thyroid gland, thyroglossal cysts and fistulæ are commoner in women. Thus, of the 117 cases reviewed, 75 occurred in females.

THYROGLOSSAL CYSTS.

GENERAL DIAGNOSIS.

The diagnosis of thyroglossal cyst is usually simple. Certain difficulties are met with from time to time; the chief of these results from a peculiar liability of these cysts to infection. If a thyroglossal cyst comes under observation for the first time when thus complicated, its true nature is easily overlooked, and a diagnosis of some inflammatory condition is made, notably an abscess 'en bouton de chemise' connected with a tuberculous pretracheal gland. Less frequently, when fluctuation cannot be obtained because the cyst is tense and small, an enlarged gland enters the question. Again, in the middle line a simple epidermoid cyst is a difficult but an unimportant differential diagnosis. In this connection it should be mentioned that a thyroglossal cyst quite frequently moves upwards on fully protruding the tongue, and this sign may serve to distinguish it from an epidermoid cyst. The translucency test is worth trying, but as only about

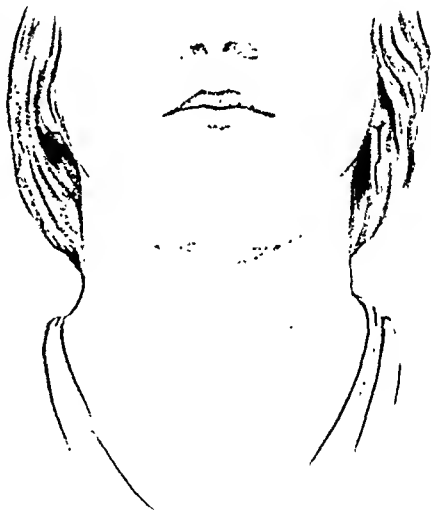


FIG. 345.—Acute inflammation in a thyroglossal cyst. This case illustrates the tendency of the accompanying cellulitis to spread laterally and surround the neck like a necklace. The cyst and the tract were later enucleated. (Sir Hugh Rigby's case.)

5 per cent of thyroglossal cysts are translucent, no importance can be attached to a negative result.

Lastly, a diagnosis of thyroglossal cyst is never complete without definitely determining the presence of a thyroid gland in its normal position, for an ectopic thyroid has probably many times been unwittingly removed. Not infrequently this thyroid is the only thyroid, for, as Spencer¹ states, "The persistence of thyroid tissue in the course of the thyroglossal tract stands as an inverse relationship to the normal development of the normal thyroid gland".

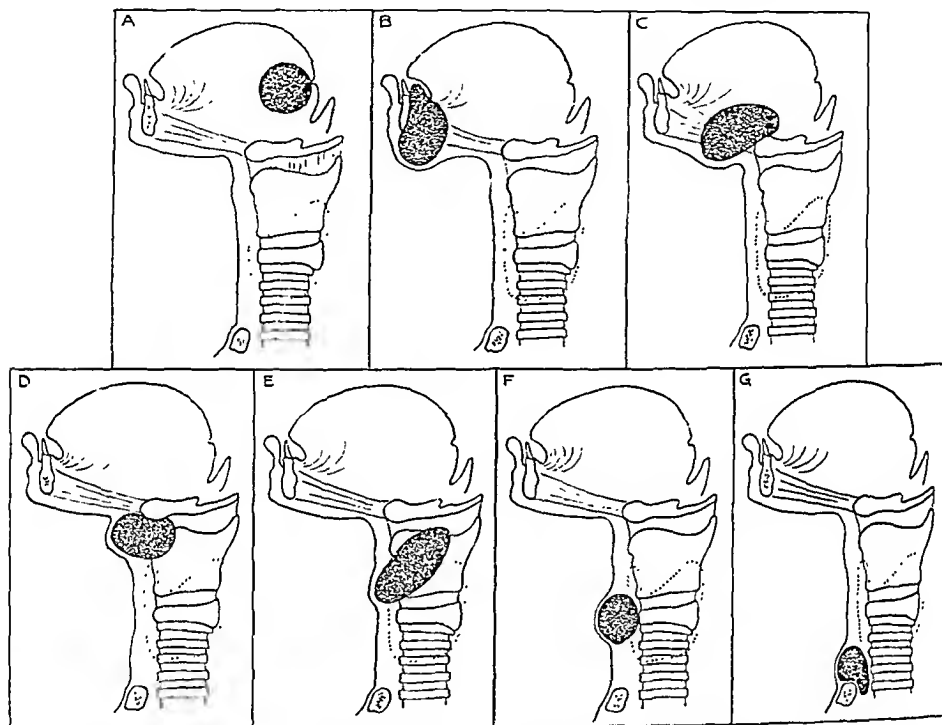


FIG. 346.—Sites of thyroglossal cysts. A, Beneath foramen cæcum (two cases at necropsy), 3 cases; B, In floor of mouth protruding beneath the chin, 6; C, Suprahypoid, 12; D, Subhyoid, 37; E, On thyroid cartilage, or membrane, 23; F, At level of cricoid cartilage, 7; G, In the suprasternal notch, 4.

As a dresser, I assisted in the out-patient clinic to remove a small lump from the mid-line of a child's neck just below the hyoid bone. The histological report was normal thyroid. The girl is now attending hospital with myxœdema. Cases of this kind simulating thyroglossal cysts have been reported.

Sites of the Cyst.—In 92 cases the site was recorded (see Fig. 346).

THE ESPECIAL CLINICAL FEATURES OF THYROGLOSSAL CYSTS IN VARIOUS SITUATIONS.

1. **At the Base of the Tongue beneath the Foramen Cæcum.**—This is the most infrequent site for a thyroglossal cyst to develop, and there was in this series but a solitary example diagnosed and treated. It occurred in an

infant of 10 weeks. The records of the London Hospital Pathological Institute afford two further instances, both of which were seen at neeropsies upon young subjects. Rare as this situation is for a thyroglossal cyst, it is the situation *par excellence* for an ectopic thyroid.

2. In the Floor of the Mouth.—
(Fig. 347).

a. Many 'lingual dermoids' are almost certainly squamous-lined thyroglossal cysts; at the present time there seems to be very little dissension upon this point. The sebaceous material within the cyst gives the swelling that yellow hue by which it is so readily recognized. In common with all other thyroglossal cysts the lingual dermoid is liable to attacks of acute inflammation.



FIG. 347.—Sublingual dermoid. An extension of the cyst can be felt beneath the chin. (Mr. Hugh Lett's case.)

Case 1.—A boy of 9 was admitted to the London Hospital with considerable



FIG. 348.—Suprahyoid thyroglossal cyst. The patient has previously received surgical treatment for a 'ranula'. (Mr. Sherren's case.)

dyspnœa and extensive œdema of the tongue. Temperature 103°. The cavity of the mouth was entirely obliterated by a cystic swelling protruding from beneath the œdematous tongue. There was considerable swelling beneath the chin. The cyst was incised, and a large quantity of material 'like curds' was evacuated. Three weeks later the cyst was excised through the floor of the mouth; the cavity was packed.

b. Relationship to Ranula.

—'Ranula' is a conglomerate term which still embraces several distinct conditions. With the advent of exact pathology, one by one various clinical entities have been recognized and withdrawn from the umbrage of ranula, a term which Hippocrates applied to a cystic swelling in the floor of the mouth, owing, it is believed, to the likeness such a swelling bore to the belly of a little frog.

At the present time it would seem desirable to reserve the term 'ranula' for a cystic degeneration of the sublingual gland or the gland of Blandin and Nuhn. Such cysts of salivary glandular origin, when they have attained considerable dimensions, may extend under the frænum linguæ to the opposite side, but the bulk of the swelling is always manifestly unilateral. Some truly median ranulae and many so-called 'deep ranulae' (i.e., those with an extension beneath the symphysis menti) are in reality the mucous variety of thyroglossal cyst. Von Fleischmann, recognizing that this type of case was unlike an ordinary ranula, attributed the condition to an enlargement of a bursa between the two geniohyoglossi muscles. Later investigation showed that there was no anatomical or pathological evidence of such a bursa.

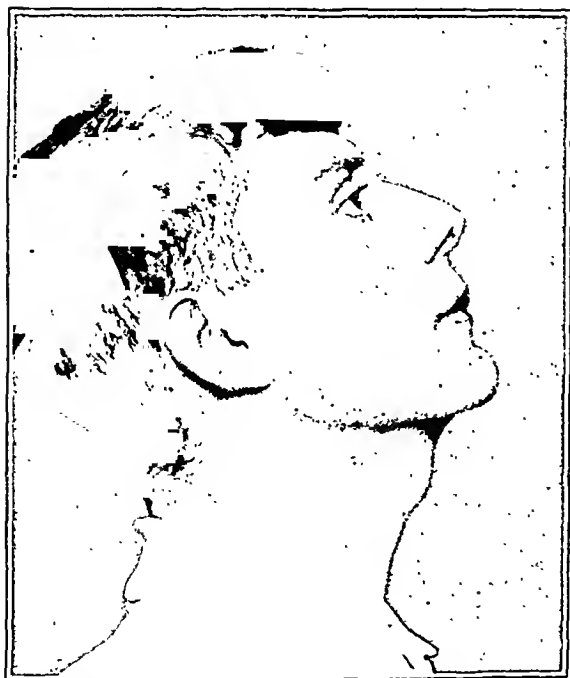


FIG. 349.—Subhyoid thyroglossal cyst. Present since early childhood, it has lately grown larger. (Mr. Walton's case.)

3. **Suprahypoid.**—A thyroglossal cyst situated immediately above the hyoid (*Fig. 348*) presents no peculiar differential difficulties.

4. **Subhyoid.**—This is the commonest site for a thyroglossal cyst (*Fig. 349*). When the patient swallows, sometimes the cyst disappears beneath the hyoid bone and remains temporarily hidden there.

A case of this kind was recently observed in a girl of 23. By asking the patient to open her mouth and fully extend the head, it was found that the cyst, which was the size of a walnut, became evident. When a normal attitude was again adopted and the patient swallowed, the cyst disappeared from view with an audible 'click'.

With regard to differential diagnosis, there appears to be very little anatomical or pathological evidence of the existence of a subhyoid bursa. There is no case of an enlarged subhyoid bursa in the records of the London Hospital. Such a condition is probably as mythical as Fleischmann's bursa.

5. **At the Level of the Thyroid Cartilages.**—It is often said that a swelling cannot be a thyroglossal cyst unless it is strictly in the middle line. The exception to this rule is the cyst in relationship to the ala of the thyroid cartilage. The thyroid cartilage, shaped like the prow of a ship, in the course of its development sweeps to one side (usually the left) the thyroglossal

tract. Thus the levator glandulæ thyroideæ in dissecting-room subjects is usually found on the left side of the thyroid cartilage; we may therefore expect a thyroglossal cyst at this level usually to be situated on the left side, and this is so (*Fig. 350*). Of the 23 cases belonging to this group it is recorded that the cyst was on the right side of the middle line in 6 and on the left in 9. This deviation often makes the differential diagnosis between an inflamed thyroglossal cyst and a tuberculous gland the more difficult.

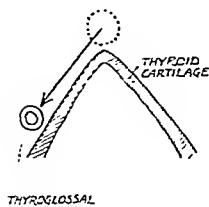


FIG. 350.

It is here that differential diagnosis has particularly to be made from a solitary thyroid adenoma, and the nearer the cyst is to the isthmus of the thyroid, the more difficult does this differential diagnosis become.

7. In the Suprasternal Fossæ.—

The thyroglossal tract can very occasionally be traced downwards far below the limits of the thyroid isthmus. It is therefore submitted that some of the 'dermoids' situated in the suprasternal fossa may have their origin in the thyroglossal tract. Such a hypothesis is strengthened by the fact that the lining epithelium of the cysts removed from Burn's space is occasionally columnar. The possibility that these are thymic duct remnants cannot be denied. A cyst in this situation is difficult to examine, but is usually thrown into prominence by fully extending the neck (*Fig. 351*).

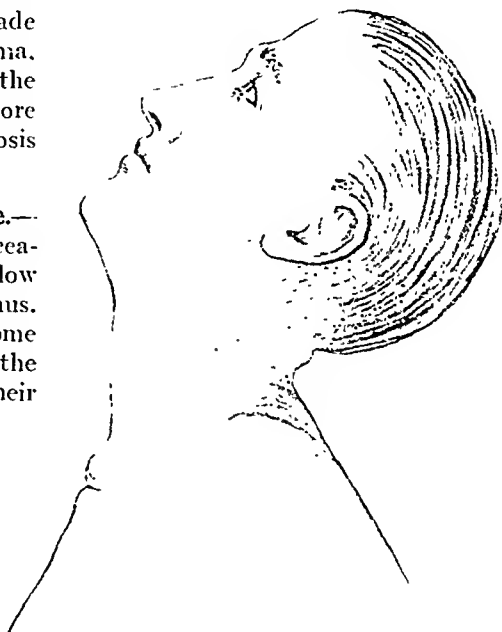


FIG. 351.—A cyst in the suprasternal notch. It is difficult to feel, and cannot be seen unless the patient fully extends his neck. (*Mr. Russell Howard's case.*)

A differential diagnosis of the cyst in this situation in an adult rests particularly from a retrosternal goitre, whilst in a child an enlarged thymus should receive consideration.

Case 2.—Bootmaker, age 48. Since childhood has had a lump in the neck. Some discomfort whilst singing was the only symptom until six months after a blow on the throat, when the lump increased in size and became painful. The cyst was excised from Burn's space, and at operation an abnormal depression was observed on the superior aspect of the manubrium sterni.

HISTOLOGICAL REPORT.—Inflamed cyst, lined by columnar epithelium.

AGE OF FIRST APPEARANCE.

In contradistinction to branchial cysts², which most frequently appear in early *adult* life, thyroglossal cysts are commonly met with in babies, and, as *Fig. 352* shows, the majority of the cases reviewed occurred in infants, or the history of the trouble dated back to very tender years. In spite of this fact it will be noticed that 19 cases had no signs until after the twentieth year.

To recapitulate: thyroglossal cysts sometimes, and branchial cysts generally, make their first appearance after the second decade of life.

It is truly mysterious that these embryological remnants, after having slumbered in the neck for years—perhaps until the prime of life or even later—should suddenly, or comparatively suddenly, burst into activity and disclose their presence in the shape of a cyst. As far as I am aware, no explanation has been recorded which accounts for the phenomenon.

The ease of thyroglossal cyst might be explained by a patent thyroglossal duct. If such a duct, opening into the mouth at the foramen cæcum, became for some reason or another occluded, then a thyroglossal cyst might be expected to result. Nevertheless, such a theory postulates a patent thyroglossal duct opening into the mouths of a certain percentage of normal individuals, for it would be unreasonable to suppose that it always became occluded. The available evidence,³ such as it is, does not substantiate this proviso. Furthermore, this theory entirely fails

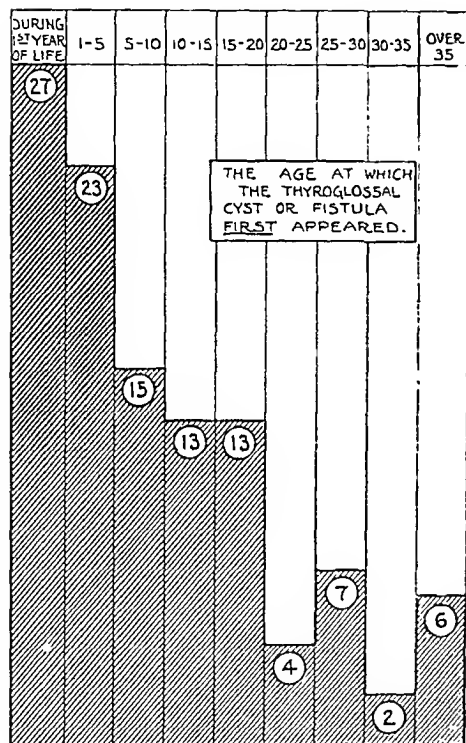


FIG. 352.—Table showing age of appearance of thyroglossal cysts or fistulae.

to explain the parallel ease of branchial cyst, which in the vast majority of cases is quite unconnected with the pharynx.

The following explanation, which holds good for both these embryological remnants, is submitted: Thyroglossal cysts and branchial cysts are not infrequently surrounded by lymphadenoid tissue. In common with the neighbouring lymphatic system, this from time to time becomes the seat of bacterial invasion. If this is so, then the lining epithelium is liable to become involved, and reacts to the infection in just the same manner as other epithelial surfaces (notably the nasal mucous membrane) by pouring forth secretion.

Some evidence in favour of this theory is as follows:—

1. Four cases of thyroglossal cyst appearing in adolescent or adult life commenced with tonsillitis or pharyngitis *for which the patient had received treatment*. Several more gave a history of sore throats which may or may not be relevant.

2. A baby admitted with an infected foot developed a thyroglossal cyst, which suppurated.

3. There is overwhelming proof, both clinical and histological, to show that thyroglossal cysts are frequently the seat of inflammation. Furthermore, the wall of branchial cysts upon histological examination are often found to be chronically inflamed.

THYROGLOSSAL FISTULA.

Raymond Johnson⁴ first pointed out that this is rarely if ever a congenital condition. Thyroglossal fistula is the result of rupture of a thyroglossal cyst.

FIG. 353.—True congenital thyroglossal fistula. The patient's father and mother noticed this condition on the day of birth. No operation has at any time been performed. In the upper part of the scar is a fistula B, which passes upwards, and, associated with this, there is a small subhyoid thyroglossal cyst. There is also a fistula D, passing downwards behind the manubrium. The intervening portion between B and D is made up of thin scar tissue, and represents the posterior wall of that portion of the thyroglossal tract between the two fistulæ. (*Sir Hugh Rigby's case.*)



Of the 31 cases of fistula included in this series there is only one which may be the exception to this now well-established rule. [Since writing this another case of true congenital fistula has come under observation (Fig. 353).]

Case 3.—Female, age 18 months. Since birth the mother noticed a tag of skin in the middle line of the baby's neck. Examination showed a small redundant flap of skin hanging down in the middle line; on lifting this up, the orifice of a

sinus was displayed. A probe could be passed into the sinus in an upward direction for $\frac{3}{4}$ in. and downward for $\frac{1}{2}$ in. There was no discharge at the time of this examination. The sinus was dissected out.

In the remaining 30 cases there is no question of the fistula being congenital; it was acquired at various times during life between the third week and the thirty-first year. Suppuration in a thyroglossal cyst, favouring as it does both spontaneous rupture and treatment by incision, plays a large part in the production of the fistula. Nevertheless, the commonest direct cause is some form of surgical intervention, for in 17 out of the 31 cases there was a clear history of the discharge commencing after an operation upon the neck. The exact nature of this operation was not always clear, and it includes both incision and excision of a thyroglossal cyst, but in the large majority of cases it is quite evident that it was the latter. Kyle⁸ suggests that, in order to

ascertain the extent of a thyroglossal fistula, lysol should be injected into the external orifice: if the tract is complete, the patient tastes this substance. So exceptional is a complete thyroglossal tract opening on the one hand at the foramen cecum and on the other externally that one wonders if this test has ever given a positive result.

It would certainly be very advantageous, especially in recurrent cases, to be able to ascertain before operation the extent and ramifications of the fistula (*Fig. 354*). Doubtless, this information could often be obtained by the injection of the tract with sodium bromide and subsequent radiography, and it seems particularly desirable that this method should be tried in all cases.

The amount of excretion discharged varies within wide limits. Sometimes it is continuous, and one male patient's chief complaint was that his collars were spoilt by it. At other times the discharge is intermittent, and in some of the latter cases a cyst was formed in the thyroglossal tract during the free interval. In uncomplicated cases when the excretion is copious it tends to be thin and watery, but in the intermittent cases it may be either viscid like white of egg or opaque and pus-like from contained cholesterol.

In fistulae of long standing which originated during infancy the orifice is situated in the neighbourhood of the cricoid cartilage, tending to be rather below than above this structure. The scar surrounding these long-standing fistulae always has a peculiar crescentic appearance, which is doubtless due to the uneven rates of growth of the thyroglossal tract and the

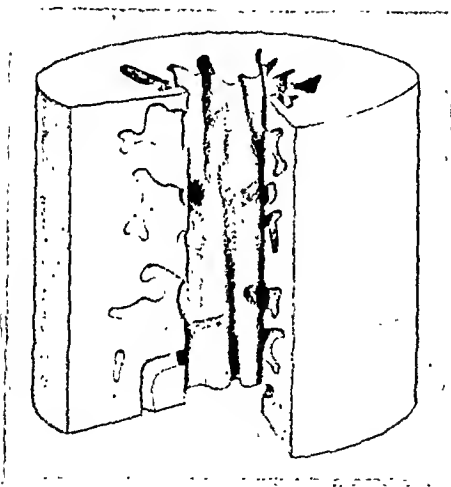


FIG. 354.—Seelig's specimen of a thyroglossal fistula reconstructed in wax from serial sections. Note the numerous lateral diverticula from the main channel. (*Redrawn from Seelig.*)

rest of the neck, causing tension at the point where the fistula pierces the integument.

From time to time cases are seen in which this peculiar scar, like an extinct volcano, alone is present. *Fig. 355* shows such a scar in a middle-aged man who came to hospital for an injury to his wrist. There was no history of a discharge from the neck. The patient suggested the scar was a 'birth mark'.

The foregoing remarks are applied to external thyroglossal fistulæ, for in this somewhat extensive series there is no case of the fistula opening into the mouth at the foramen cæcum. Freer⁵ has observed an example of the latter in which the discharge of a thyroglossa fistula into the postlingual space caused obstinate cough; whilst New⁶ has injected bismuth paste into such a sinus, demonstrating its extent radiologically.

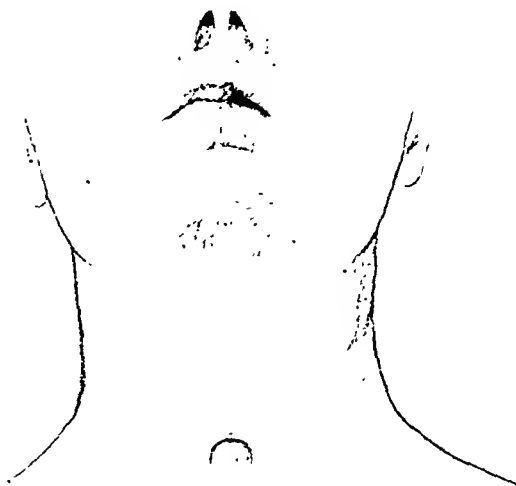


FIG. 355.—A thyroglossal scar, without fistula. The patient came to hospital with an injury to his wrist. (*Mr. Walton's case.*)

TREATMENT.

The practical importance of this little subject is liable to be overlooked until we examine the results of removal of thyroglossal cysts and fistulæ. Without the advantage of any special investigation by 'following up' cases, 26 per cent of the total cases reviewed were proved by the records to be recurrent. A proportion of these have been operated upon more than twice.

It is necessary to make it perfectly clear that by 'recurrent' is understood both cases which were initially operated upon at the London Hospital and those which originally received similar treatment elsewhere. In view of the probable mutual exchange of failures amongst the hospitals, 26 per cent should represent a mean average.

Two methods of treatment have given such unsatisfactory results that they have now been largely discarded: (1) The simple dissection of a cyst, combined with proximal ligation of its thyroglossal pedicle; and (2) Treatment of thyroglossal fistulæ by means of scraping and cautery.

When an operation for a thyroglossal cyst is undertaken, the goal in view is to extirpate once and for all the cyst and every vestige of the tract. The very great majority of thyroglossal cysts are situated in some part of the

infrahyoid portion tract. The extirpation of this portion of the tract is comparatively easy; there is nothing to disturb the even tenor of the dissection as far as the hyoid bone. It is here that trouble begins and the conflicting views of leading anatomists* upon the relationship of the tract to hyoid are forcibly impressed upon the operator. Often it is here that the thyroglossal pedicle, already considerably attenuated, seems to dwindle into mere shadow, and the dissection has, perforce, to be terminated. The operation is sometimes considerably facilitated by simple division^o of the hyoid bone, but even this step does not necessarily secure success.

Sistrunk's Operation.

—Sistrunk,⁷ realizing the unsatisfactory result of many of these cases, has devised a technique which circumvents the difficulties encountered in the hyoid region and eradicates the supra- as well as the infrahyoid portion of the thyroglossal tract.

The operation is usually carried out through a transverse incision about the level of the hyoid bone (*Fig. 356*). The thyroglossal tract having been dissected as far as the body of the hyoid, the attachments of muscles in the immediate vicinity of this structure are separated, and $\frac{1}{4}$ in. of the centre of the bone is resected. Then, without attempting to isolate the duct, the tissues are 'cored' through until the foramen cæcum is reached, allowing about $\frac{1}{3}$ in. on every side of the duct. In order that this procedure may be carried out it is

- * 1. The thyroglossal tract passes through the body of the hyoid (Professor Parsons).
2. The thyroglossal tract passes in front of the body of the hyoid (Professor Frazer).
3. The hyoid bone develops in the course of, and interrupts the continuity of, the thyroglossal tract (Sir Arthur Keith).

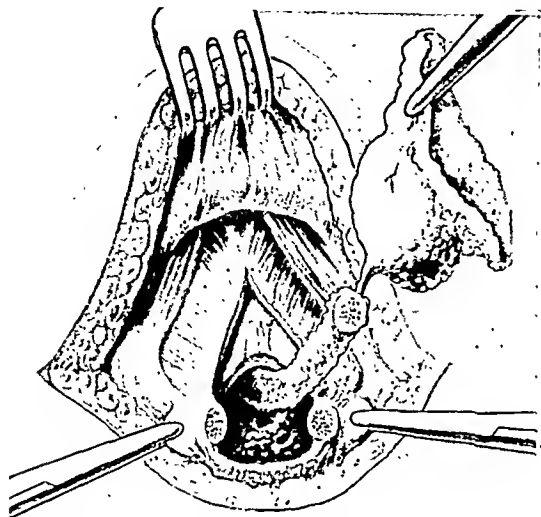


FIG. 356.—*Sistrunk's operation.* The centre of the body of the hyoid has been resected and the suprahyoid portion of the tract is in the course of being enucleated. (Redrawn from Sistrunk.)

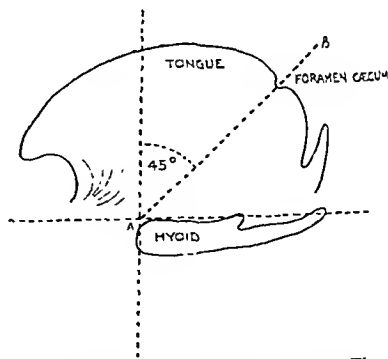


FIG. 357.—*Sistrunk's operation.* The suprahyoid portion of the thyroglossal tract is eradicated by 'coring out' the tissues along the line A-B.

necessary to know the exact course of the suprahyoid portion of the thyroglossal tract. If two intersecting lines are drawn, one horizontal and one perpendicular to the superior border of the body of the hyoid bone, then the foramen cæcum lies upwards and backwards from the hyoid at an angle of 45° , and it is along this line that the dissection proceeds until the cavity of the mouth is reached (*Fig. 357*). The dissection now completed, the opening in the mouth is closed. Several sutures are used to draw the geniohyoglossi muscles together. The tissues around the cut ends of the hyoid bone are brought together with chromic gut sutures in such a manner as to approximate the cut edges of the bone. A small rubber tube is inserted from this point to the skin incision, which is now closed. The dissection removes *en bloc*:—

1. The thyroglossal tract.
2. The centre of the body of the hyoid bone.
3. Portion of the median raphé of the mylohyoid.
4. Portion of the geniohyoglossi muscles.
5. The foramen cæcum.

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A LARGE CAVERNOUS HÆMANGIOMA OF THE LEFT LOBE OF THE LIVER CAUSING OBSTRUCTION TO THE CARDIAC ORIFICE OF THE STOMACH.

By CECIL P. G. WAKELEY, London.

ALTHOUGH cavernous angiomas are the commonest innocent tumours met with in the liver, they are most frequently multiple and of small size; and even if they grow to a considerable size they rarely give rise to symptoms. It is only when the capsule of the tumour becomes converted into fibrous tissue that a large angioma can be easily palpated per abdomen. For where no capsule is present the cavernous spaces abut directly on the liver tissue, and form a very soft tumour. In the case described below the angioma was about the size of a closed fist and easily palpable; it was mistaken on account of its hardness for a carcinoma of the cardiac orifice of the stomach. The tumour was hard, and on section was found to have a very dense fibrous capsule; it was not compressible even when it was removed from the liver. In fact, the tumour might easily be termed a fibrous angioma on account of its very thick fibrotic capsule. Some authorities still consider that such tumours may be regarded as fibromata containing dilated inter-communicating vascular channels; while others deny that they are of the nature of true tumours, but consider that they are dilatations of the normal blood-spaces. The following is the history of the case:—

Mary L., age 62, complained of difficulty in swallowing which came on insidiously five years prior to her admission to King's College Hospital on May 14, 1924. The patient stated that the food seemed to stick in the 'pit of the stomach' and was only shifted by swallowing some water after each mouthful of food. In April, 1924, all solid foods were vomited and the patient was compelled to take fluid diet. For the year previous to admission she had been steadily losing weight. She had no history of jaundice.

ON EXAMINATION.—The patient was seen to be thin and worn, with marked retraction of the abdomen. A hard lump about the size of an orange could be palpated in the left hypochondriac region; it was movable on respiration, its surface appearing to be slightly grooved. The upper border of the lump could not be made out. There was no increase in size of the liver and no free fluid in the abdomen. A diagnosis of carcinoma of the lower end of the œsophagus or cardiac end of the stomach was made.

ON ADMISSION.—On the patient's entry into hospital a barium meal was administered. She did not vomit the meal, and a skiagram (*Fig. 358*) taken immediately afterwards revealed some opaque meal in the stomach, but the major portion was retained in the lower end of the œsophagus. A skiagram taken two hours later showed the barium in the stomach, duodenum, and small intestine, while there was still a considerable portion in the

lower end of the œsophagus. A skiagram taken after five hours demonstrated that the meal had reached the cæcum; there were also opaque residues in the œsophagus, stomach, and small intestine. The fourth skiagram, taken after eight hours, revealed the majority of the meal in the cæcum and ascending colon, while there were still traces of the meal in the œsophagus, stomach, and small intestine. The fifth skiagram, taken twenty-four hours after the

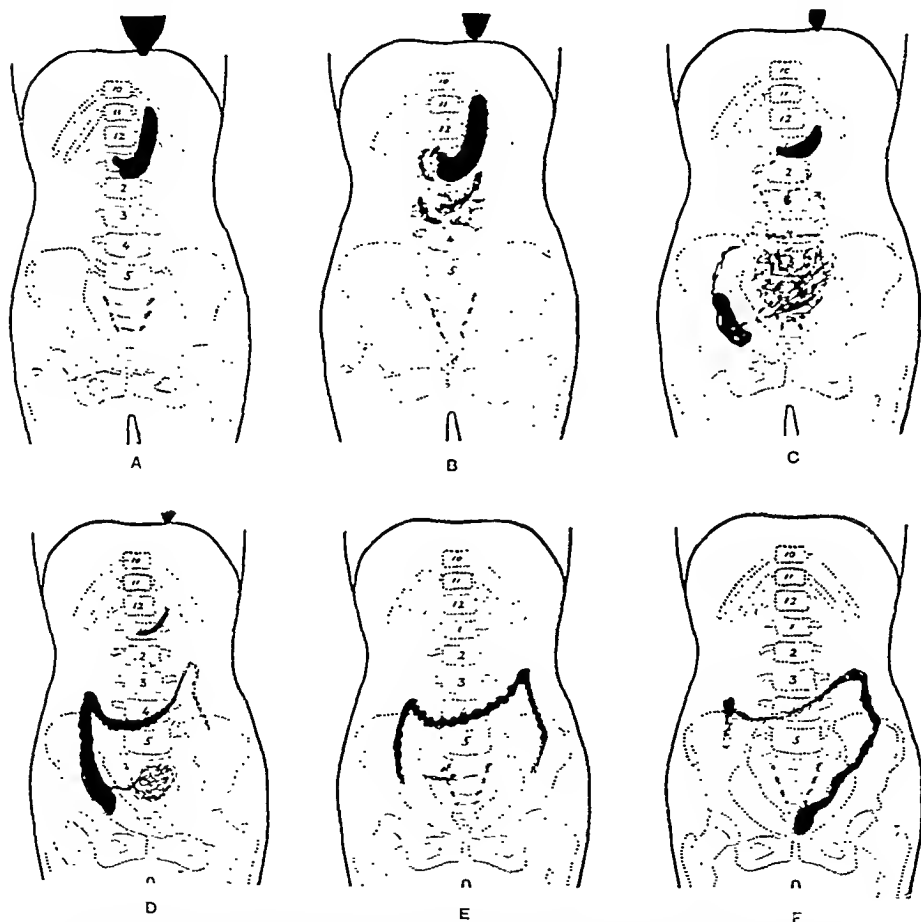


FIG. 358.—Drawings of skiagrams taken after ingestion of barium meal. A. Immediately after; B. After 2 hours; C. After 5 hours; D. After 8 hours; E. After 24 hours; F. After 48 hours.

meal was given, showed that the ascending, transverse, and descending colons contained all the opaque meal; while the sixth skiagram, taken after forty-eight hours, demonstrated that the meal was mainly in the descending and sigmoid colons and the rectum.

OPERATION.—The skiagraphic findings seemed to confirm the clinical diagnosis, and a gastrostomy was proposed to the patient, who willingly

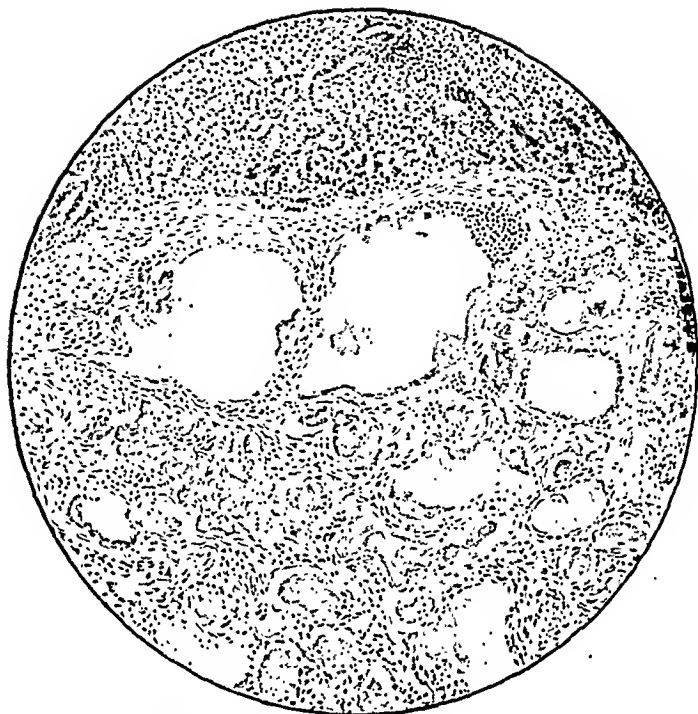


FIG. 360.—Angioma of liver. ($\times 80$.)

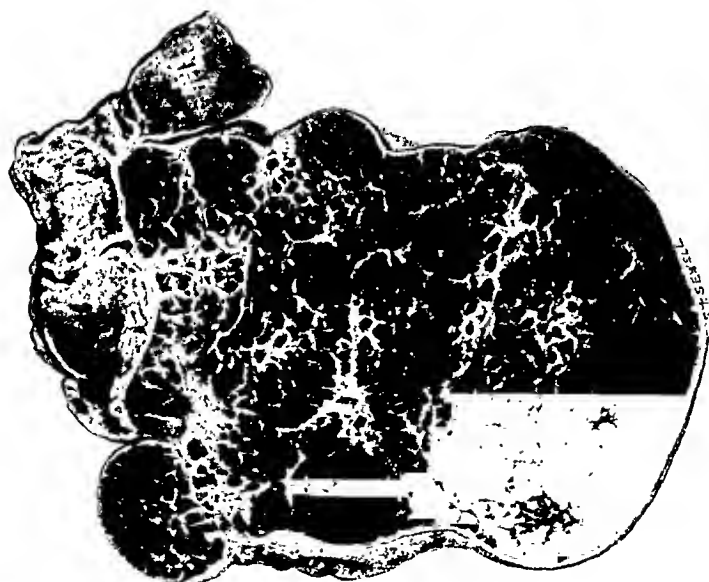


FIG. 359.—Angioma of liver. (Natural size.)

consented. A laparotomy was performed on May 23, 1924, under gas and oxygen anæsthesia. An incision was made through the left rectus muscle and the peritoneal cavity opened. The stomach was found to be normal, no tumour could be felt, and there was no growth at the lower end of the œsophagus, as a finger could be passed upwards after invaginating the stomach wall. A hard tumour was felt, however, in the extreme end of the left lobe of the liver; it was about the size of a closed fist. Owing to its hardness it was thought to be a malignant neoplasm; a careful examination of the abdomen did not reveal any sign of a primary tumour, so it was decided to remove the growth from the liver by the diathermy cautery. The abdominal viscera were packed off with gauze, and the growth, with half an inch of liver tissue, was removed. Hæmorrhage was not great and was easily controlled by gauze packing, which was left in for forty-eight hours. The abdomen was closed in three layers; a drainage tube was inserted. The gauze packing was removed on the second day under nitrous oxide anæsthesia; the tube was removed three days later. The wound healed soundly.

The patient was taking solid food after six days and rapidly put on weight. A barium meal taken three weeks after the operation (*Fig. 361*) revealed a normal stomach with a well-marked duodenal cap; there was no sign of obstruction at the cardia.

The tumour on section (*Fig. 359*) was seen to be surrounded by a definite capsule. The microscopical section (*Fig. 360*), taken through the edge of the tumour so as to include a small piece of liver tissue, shows the typical cavernous angioma met with in the liver; dilated capillary spaces can be seen extending into the liver tissue. The endothelial lining of the spaces is well marked.

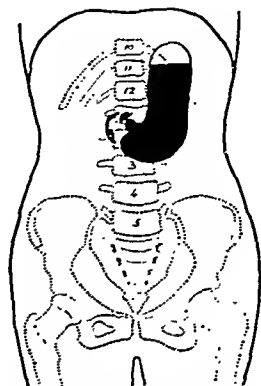


FIG. 361.—Drawing from skiagram taken immediately after barium meal, showing normal stomach outline.

A CASE OF UNILATERAL AFFECTION OF THE SKELETON OF UNKNOWN ORIGIN.

By H. A. T. FAIRBANK, LONDON.

ALTHOUGH the curious, and possibly unique, radiographie findings in this case more than warrant its publication, the author has a special object in view in reporting the details. So far he has failed to find anyone who has observed a similar case or who can explain the appearances seen. He hopes that this report may catch the eye of someone who can help him with the diagnosis and who will be good enough to communicate with him. It is most distressing to the parents of the boy that no prognosis can be given.

HISTORY.—The patient is 12 years of age. The history is that after an uneventful infancy it was noticed that he always ran awkwardly, turning his toes out, and especially those of the right foot. He got over a stile clumsily with the right leg, and preferred to cross with the left leg leading. Though nothing more definite could be obtained in the way of a history, there was certainly something which drew his parents' attention to the right leg.

Some fifteen months ago he developed rheumatic fever, which affected his heart. Only two or three joints were involved, and these cleared up in three days. After many months' absolute rest in bed he began to get about again, and had recently been passed fit for school, though still unfit to play games. As the awkwardness of the right leg had been rather more noticeable since his long illness, it was thought advisable that the cause of this should be investigated before he returned to school. His medical attendant, Dr. A. Bevan, and Dr. Poynton, who also saw him several times during his long illness, are emphatic as to the absence of any arthritis during that period which could have accounted for the bone changes. There is, moreover, no history of arthritis at any time, nor of any illness which could have a bearing on the case. He has never sustained a fracture. As to the family history, he is the child of apparently healthy parents, who are not cousins. His mother had two healthy children by a previous marriage. There is no history of bone affections in the family.

ON EXAMINATION.—The patient proved to be a well-developed boy of very fair physique considering his recent illness. He did not limp, complained of no pain, and stepped over a chair readily enough with either leg. The right thigh was thinner than the left by three-quarters of an inch, but this leg was half an inch *longer* than the left. The lengthening was mostly in the femur and only slight in the tibia. The calves were equal in size. The right foot was slightly larger than the left. Both feet were markedly flattened, though supple. The arms were equal in length. Nothing abnormal was discovered in any of the joints of the legs or arms. The movements were perfect and equal on the two sides of the body. The spine showed a postural scoliosis of mild degree, obviously the result of the inequality of the legs.

There was a slight inclination to hold the left shoulder higher than the right. The reflexes were normal. The heart was enlarged and a loud mitral murmur was to be heard. The urine contained a minute trace of albumin. Bence-Jones's albumose was not present. No focus of infection was discovered. A routine X-ray examination of the hips revealed the unusual character of the case, and led to an extensive radiographic investigation of the skeleton by Dr. Bertram Shires.

X-ray Findings.—The right half of the pelvis (*Fig. 362*), including the outermost part of the right half of the sacrum, and the right femur showed



FIG. 362.—The bones about the hip-joint. (The bones on the two sides are really of equal size.)

a very marked difference from the corresponding parts on the other side. The general appearance of the bone seems to approximate more closely to what is usually termed 'atrophy' than to any other abnormal condition. Here and there the appearances rather suggest osteitis fibrosa, but the similarity is only apparent at a few spots, and the gross changes in the bones as a whole are quite unlike this disease. Though atrophy seems to be the best word to describe the condition seen, the changes in the bone differ in several respects from those usually noted in atrophy associated with arthritis and disuse. There is a curious striated appearance, the lamellæ—

particularly those running up from the ealear femorale—standing out boldly against the bone around, which is less dense than normal. In addition, the femoral head and the bone adjacent to the acetabulum are mottled and sprinkled with dense spots. The shaft of the femur shows a solid tube of compact bone, not thinner than the normal as in an ordinary atrophic bone, but the interior of the shaft is less dense than that of the other side. The

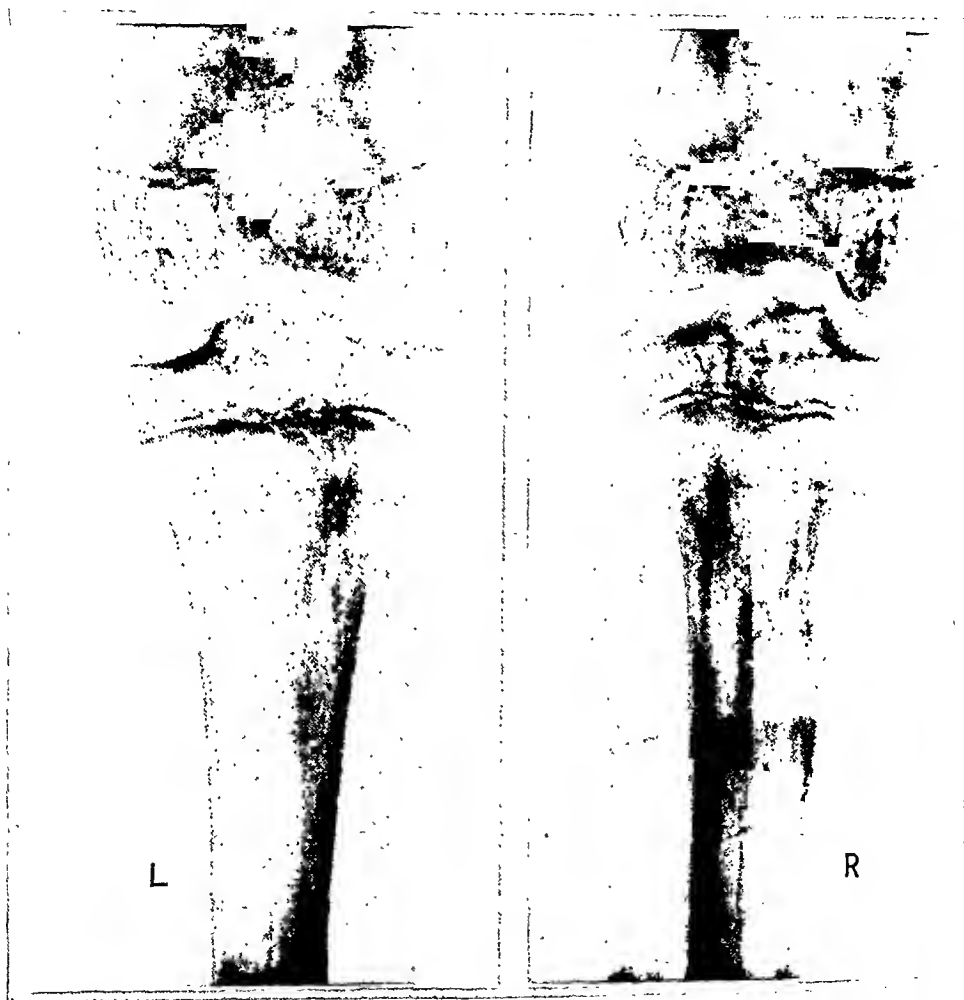


FIG. 363.—The bones about the knee.

shaft of the right femur is at least as thick as that of the left. There is nothing to suggest that the joint surfaces and articular cartilages are affected: this agrees with the clinical findings. There is no alteration in outline of the bones. The right knee (*Fig. 363*) shows similar changes, most marked in the epiphyses of the femur and tibia. The longitudinal striation of the tibial shaft is worthy of note. In the ankles and feet (*Fig. 364*) the difference in density on the two sides is very striking. The striation is marked in all

the bones, while the dotted appearance is not very obvious, though certainly present in the epiphyses of the tibia and fibula and in the ensoid. The pencilling of the outlines of the bones is not so marked as in the typical atrophic foot. The right arm (*Fig. 365*) shows similar changes, but to a much less obvious degree. The upper end of the humerus shows the typical dotted appearance, which is in strong contrast to that of the left; the upper end of the shaft shows longitudinal striation. Changes are also seen in the acromion and glenoid region.

Sir Robert Jones and Dr. Thurstan Holland, who kindly took a great interest in the case, pointed out that the bones of the left arm and leg were



FIG. 364.—The bones about the ankle.

not quite normal, the changes being similar to those seen on the right side, but much less marked. There is not much to choose between the elbows; both ulnæ show striation at their upper ends. The hands show rather more distinct differences, the changes on the right being similar to those seen in the leg. The os magnum shows a large dense spot. The skull shows no changes except that in one antero-posterior view there is seen a density in the orbital regions, suggesting sclerosis or thickening of the great wing of the sphenoid on the right side. A second antero-posterior view failed to bring out this difference. Radiograms of the spine and ribs showed rarefaction changes in the head of the twelfth rib on the right side, but nothing abnormal otherwise.

To sum up the result of the X-ray examinations, we may say that the

right half of the pelvis, the right lower limb, and to a smaller degree the right arm, show an abnormal translucency to X rays. The chief lamellæ, however, stand out boldly, and in many places give an appearance of striation which is unusual. In addition a curious dotted appearance is seen in some epiphyses, and in the juxta-acetabular region of the os innominatum. Lastly, the bones of the limbs on the left side are not quite normal.

While it seems possible, or even probable, that the long period of rest incidental to the acute rheumatic attack might account for the abnormal



FIG. 365.—The bones about the shoulder.

atrophic changes seen in the left limbs, this would not explain the conditions seen on the right side. As already stated, fibrocystic disease of the bones is simulated only at a few places, the general appearance of the bones in this case being entirely unlike those seen in osteitis fibrosa. Compared with atrophy as usually seen, there are, as has been pointed out, several differences. Moreover, no cause for such atrophy of one side of the body has been discovered. Except for the very fleeting rheumatic infection, there is no history whatever of arthritis of any joint, and no history of rest or immobilization which should not have affected all four limbs to an equal extent. In this

connection it is interesting to note that both Sir Robert Jones and Dr. Calvé, in kindly writing to the author about the case, recall cases of arthritis of doubtful origin where the radiograms revealed changes of a somewhat similar kind, but these changes were localized to the region of the affected joint. So far we have not heard of a case where the changes were similar to those seen in this case and were equally widespread.

Dyschondroplasia has been suggested as an explanation. Dr. Thurstan Holland was kind enough to send us a reference to a paper on some extremely interesting experimental work on this disease carried out by Bentzon.¹ This is, it is true, an affection of the limbs of one side of the body, but the radiographic appearances are quite unlike those seen in this case. The masses of cartilage in the ends of the diaphysis of the affected bone are more or less columnar in shape, and, as Dr. Bentzon points out, these columns are arranged in a radiate manner from the point of entry of the nutrient artery towards the epiphyseal line. The radiate striation is quite unlike the longitudinal striation seen in this case. Moreover, in the two or three instances we have seen, the affected limb was shorter, not longer, than its fellow, and this would seem to be the general rule.

As regards the dotted appearance, we have a radiogram of a leg, from the case of a baby of one month, with a congenital short leg. In this leg all the epiphyses, as well as the tarsal bones that show any ossification, are stippled. These portions of the bony skeleton look as if a brush had been loaded with paint and flicked at them, so that instead of one centre of ossification there are a dozen or more. The diaphyses in this case were not obviously abnormal. Unfortunately the case was lost sight of. My colleague, Dr. Donald Paterson, once let me see a case where all the limbs showed stippled epiphyses; in this instance the diaphyses were abnormally short and stout, with enlarged ends. Except for the dotted appearance of the epiphyses, the bones in these two cases bear no resemblance to those in the case now being considered.

Osteogenesis imperfecta was also considered, but discarded as giving quite different radiographic appearances. The obvious strength of the tubular shafts of the long bones in this case is in marked contrast to the fragile appearance of the bones in the majority of cases of osteogenesis imperfecta. Moreover, this boy has never sustained a fracture.

Finally, we have to admit that we can offer no adequate explanation of the changes seen in this boy's bones. It would seem to be more than probable that the changes date from birth, or at any rate were present before the attack of acute rheumatism, and that they are not progressive. Time and further X-ray examinations can alone decide this latter point. Seeing that the affection is not a general one, no treatment, by drugs or otherwise, seems likely to be of the least use. As the affected leg is already longer than the other, local treatment to improve the nutrition of the limb seems to be contra-indicated.

As the heart condition demands abstention from all active exercise, and the bones have hitherto been equal to the strains put upon them, the boy has been allowed to return to school.

REFERENCE.

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VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

THE CLINIC OF PROFESSOR CLAIRMONT IN ZURICH.

THE Clinie of Professor Clairmont is at the Kantonspital. It consists of about 230 surgical beds. Professor Clairmont has on his staff two 'first' assistants, and eight other 'official' whole-time assistants. In addition to this, at the



FIG. 366.—Professor Clairmont in his Clinic.

time of our visit he had five resident 'voluntary' assistants who, one presumes, are not paid, and also some non-resident 'voluntary' assistants.

The Clinie is the official one for the instruction of medical students. Every patient, whether in- or out-patient, pays something according to his

means. If too poor to pay, then his parish pays. Insurance companies have usually a contract with the hospital, and pay for the treatment of accident cases.

The programme of work at the Clinic during the two days spent there was extremely full and varied. Five operations were done each morning. Each afternoon was spent in visiting either the wards or subsidiary departments. The visit to the new Dermatological Institute was especially interesting.

The operations usually commence at 7.30 a.m. They were made more than usually interesting by each visitor being supplied the night before with a very detailed history of the cases, and also the results of the special examinations. Thoroughness was the key-note to everything seen at the Clinic.

We witnessed the following operations :—

1. **Second-stage Operation for Removal of Cerebellar Tumour, etc.**—(Operation 8.35 to 9.7.) The 'first stage' of the operation had been done on Sept. 5. The patient was a man, age 26, whose illness had commenced with giddiness and headache six months previously. The headache, at first diffuse, later had become localized in the occipital region. Vomiting had been frequent. Mental symptoms had been so marked that the diagnosis of dementia præcox had been made, and he had been sent into an asylum.

Soon after admission, marked cerebral symptoms had again appeared, and he was transferred to the surgical clinic. He complained of headache, and there was tenderness on percussion over the occipital region. He walked with an ataxic gait, and there was hypotonia of the muscles of the right leg. Both knee-jerks were increased, and Babinski's sign was present on the right side. The right eye could not be closed. Nystagmus was present, slow to the right and quicker to the left. There was paralysis of the right external rectus muscle. The corneal reflex on the right side was diminished, on the left side increased. The field of vision was contracted on both sides, but more so on the right. There was papillitis on each side, with retinal hæmorrhages. There were symptoms of irritation of the left labyrinth. The urine contained a small amount of albumin, and some red and white blood-corpuscles and *Bacillus coli communis* were present.

The diagnosis made was that of tumour of the cerebellum, probably in the upper part of the right vermis. At the first stage of the operation on Sept. 5, a large area of the occipital bone had been removed. The perieranium had been turned down with the skin-flap; the bone had not been preserved. The dura mater was found to be bulging. At the end of the operation, which had been done under a local anæsthetic, the patient had lost consciousness. The pulse was then 160 per minute. Consciousness was quickly regained after the injection of caffeine and camphor.

The second stage of the operation, which we witnessed, was done under general anæsthesia by means of ether given by a Dräger apparatus; regular readings of the blood-pressure and the pulse- and respiration-rates were taken by the anæsthetist and charted. The dura mater was exposed and found to be bulging. It was opened by a semicircular incision, and a cyst on the left side of the cerebellum was evacuated. The anæsthetist reported that he felt every manipulation of the brain by the operator affect the rate of the pulse. If pressure were made on the brain, the pulse was 80 per minute;

when pressure was removed, it was 120 per minute. A small portion of the cyst wall was removed for examination, and in a few minutes the pathologist reported that it was a gliosarcoma.

The dura mater was closed with separate catgut sutures, and the skin incision with separate silk sutures. The operation area was protected by a moulded papier-mâché splint, which was kept in position with a starch bandage. It was proposed to nurse the patient lying on his chest for the first twenty-four hours.

2. Removal of the Right Internal Semilunar Cartilage.—(*Operation 9.20 to 10.10.*) The patient was a male, age 24, who gave a typical history of injury with subsequent locking of the joint and synovial effusion. The operation was done under general anaesthesia. The operator stood on the left side of the patient; the leg was extended; no tourniquet was used.

An internal J incision was employed, the lower curve being across the tubercle of the tibia. It commenced about $2\frac{1}{2}$ in. above the patella, and was about 6 in. in length. The skin was reflected and the quadriceps divided longitudinally in the line of the incision where the muscle-fibres join the tendon, thus exposing the capsule of the joint. The capsule was incised just anterior to the internal lateral ligament. The synovial membrane was then opened along the length of the wound. The knee was bent to a right angle, and an extensive view of the interior of the joint obtained. An adhesion between the retropatellar pad of fat and the anterior end of the internal condyle of the femur was exposed and divided. The internal cartilage had a 'bucket-handle' fracture, and was completely removed. The incision was closed in layers, fine silk being used throughout. After the dressings had been applied, the limb was put in a plaster-of-Paris gutter-splint which had been made previously, extending about 8 in. above and below the knee-joint.

In the after-treatment the limb is immobilized for seven to ten days on the splint. The splint is then removed and the limb rested on a cushion, active movement being allowed and massage given. Passive movement is not allowed until the end of the second week at the earliest. The average stay in hospital is five weeks, and work is usually commenced in eight weeks.

3. Thyroidectomy.—(*Operation 10.15 to 11.15.*) The patient was a woman, age 31. At the age of 15 she had had rheumatic fever and endocarditis. Since that time, in addition to the heart affection, she had had stiffness of the neck and had been unable to open her mouth fully. The goitre had been present since the age of 11. It had increased in size during each of her five pregnancies, and after confinement had gone down. The goitre had increased in size during the last two months, and was causing dyspnoea. She was not now pregnant.

Physical Examination.—The heart shows no dilatation, but there is a systolic murmur at the apex. The thyroid gland is diffusely enlarged, but more on the left side than the right. It is somewhat fixed to the deeper structures and moves only slightly on swallowing. There is dullness on percussion over the upper part of the sternum. A skiagram shows that the left auricle of the heart is enlarged; the trachea is shortened, and pushed over to the right, in addition to being slightly compressed. The cervical vertebrae show lordosis due to bony ankylosis between the articular processes of

the 2nd, 3rd, and 4th cervical vertebrae. There are rudimentary cervical ribs. The Wassermann reaction is negative. Laryngoscopy shows the vocal cords moving normally. The trachea cannot be seen.

Operation.—The anaesthesia employed was regional anaesthesia with novocain 1 per cent containing 5 min. of adrenalin in each ounce. The incision was the lower collar incision. The pretracheal muscles were divided transversely. The thyroid was exposed; the left inferior thyroid vessels were exposed as they entered the capsule. The vein was ligated before the artery. This step is considered to be important if any symptoms suggesting Graves' disease are present. The site of ligature was just outside the capsule.

The gland was then dislocated forwards, the capsule opened, and the vessels were ligated within the capsule as they entered the gland. The left superior thyroid vessels were ligated last. The left lobe was enucleated, the whole of the isthmus removed, and two-thirds of the right lobe resected. The raw surface of the remaining external third of the right lobe was cut in coneave fashion, so that it could easily be covered by approximating the edges. The patient sat up to have the bandages applied.

So far as regards the regional anaesthesia employed, the experience of the Clinic was that in 50 per cent of the cases it was good, and 10 per cent were total failures.

4. Thoracoplasty for Tuberculosis of the Right Lung with Cavity Formation and Hæmoptysis.—(*Operation 11.15 to 12.40.*) The patient, a male, age 26, had pleurisy at the age of 11 months, and during childhood measles and scarlet fever. In April, 1922, he had been admitted to a sanatorium for progressive tuberculosis of the upper lobe of the right lung. On May 18, 1923, artificial pneumothorax had been induced on the right side on account of hæmoptysis, and he returned to work in April, 1924. In August, 1924, he had had four attacks of hæmoptysis. He also had pyrexia and night sweats. The sputum contained numerous tubercle bacilli. He had had a leucocytosis of 16,400. X rays show tuberculosis of the upper lobe of the right lung with cavity formation.

The operation was done under local anaesthesia with 1 per cent novocain. A long vertical incision was made parallel with, and about $1\frac{1}{2}$ in. away from, the spinous processes. The incision commenced at the level of the 6th dorsal spine and ended at the 12th. A small portion of the posterior part of each rib, about 2 in. long, was removed, commencing with the 7th and extending down to the 10th. The portion removed was divided first anteriorly and then posteriorly. No attempt was made to include the angle. The skin incision was then continued upwards, and a similar portion of each of the remaining ribs removed, up to and including the 1st rib. The removal of the portion of the 1st rib was very difficult, and it had to be nibbled away with bone-cutting forceps.

A long rubber drainage tube with many lateral openings was laid along the whole length of the wound and brought out at the lower angle of the incision, the split muscles being stitched over it. The skin incision was closed, and the right side of the chest enclosed in an elastic bandage. The bandage was made of strips of elastic webbing, 2 in. broad, stitched at each end to adhesive strapping, which, being fixed to the skin, held it in position.

5. Removal of Bullet from the Body of the 5th Cervical Vertebra.—(*Operation 12.50 to 1.50.*) The patient, a boy of about 12 years, was shot accidentally by one of his playmates on July 16, 1924. The missile entered just below the angle of the lower jaw on the right side. When admitted to hospital there was profuse bleeding, and for five days he was unable to move his head in any direction. He had pyrexia; there was no paralysis, and no loss of sensation. He returned home on the sixteenth day after the accident. Since then he has had periodic attacks of severe pain in the neck radiating towards both shoulders.

Physical Examination.—The turning of the head is limited especially to the right side. Any attempt to bend the head backwards gives rise to severe pain. He can bend the head forwards quite normally. Pressure over the transverse processes of the cervical vertebræ is painful, especially on the right side. On palpation of the pharynx through the mouth, a small hard protuberance can be felt just above the larynx and to the right of the middle line. The protuberance, the size of a pea, is thought to be the bullet projecting from the body of the vertebra. The radiograph shows the projectile in the body of the 5th cervical vertebra, and also a fracture of the body of the 4th cervical vertebra.

Operation.—This was begun with a local anæsthesia, but later a general anæsthetic was administered. An incision about 3 in. long was made behind the right sternomastoid muscle, and the dissection carried down to the deeper structures. A sear was found between the pharynx and the prevertebral muscles. An unsuccessful search with the finger in the wound was made. The assistant could feel what was thought to be the projection of the bullet with the finger in the mouth, but it could not be reached by the operator, although bone was chiselled away. After searching unsuccessfully for an hour the operation was abandoned.

In the afternoon a visit was made to the Roentgen Institute of the Kantonspital. The Director, Dr. Schinz, showed a series of extremely good skiagrams of typical conditions, those illustrating gall-stones and those of the human foetus being especially good. Dr. Schinz explained the difficulty in obtaining radiological evidence of the presence of gall-stones, even if calcium is present in the stone, by the fact that the wall of the diseased gall-bladder is often more impervious to X rays than the gall-stones themselves.

The department contains a very complete deep X-ray therapy plant, which was explained by Dr. Schinz and his assistants.

On Tuesday, Sept. 16, the second day of the visit, the following operations were witnessed:—

1. Cholecystectomy.—(*Operation 7.45 to 8.40.*) The patient, a woman, age 33, had been taken ill on Aug. 13, 1924. She was admitted on Aug. 17, with typical cholecystitis. The condition had not fully cleared up. It was a first attack. Under general anæsthesia the abdomen was opened by a vertical transrectal incision. The gall-bladder was distended and full of stones. The ducts were exposed after separating many adhesions with a blunt dissector. No stone was present in the ducts. The gall-bladder

was dissected off the liver, beginning at the fundus, and burst while it was being manipulated. The cystic artery was exposed, and tied with silk. The junction of the cystic and common duct was seen.

The gall-bladder was removed. The common duct was then fixed with two catgut ligatures to act as retractors, and the duct opened between the ligatures. Metal bougies were passed down the duct into the duodenum to dilate the sphincter muscle. The common duct was then closed with catgut, and the abdomen closed after a tube had been put down to the site of incision in the common duct.

2. Suspected Duodenal Ulcer.—(*Operation 8.15 to 9.30.*) The patient was a man, age 26, a decorator. In 1921 he had lead poisoning, with severe colic and vomiting after meals. He was treated at home, but he has never felt well since. He had a distended feeling after meals, and made himself sick in order to get relief. He continued working until the spring of 1921. From that time he has had vomiting, frequently after every meal, and constant pain in the epigastrium. The pain bears no relation to food: it is, however, worse when he is hungry. He has lost 22 lb. in weight since March, 1921.

Physical Examination.—He is a well-nourished man with diffuse goitre. There is tenderness in the epigastrium $1\frac{1}{2}$ in. above the umbilicus, but no rigidity. There is no lead line on the gums. The gastric analysis shows increased acidity. Occult blood was present in the stools only once out of four examinations. The X-ray report states that there is a superficial duodenal ulcer.

Operation.—Under general anaesthesia the abdomen was opened in the middle line. No ulcer on the duodenum or stomach could be found. No gall-stones were present. The appendix showed chronic inflammatory changes and was removed, the stump being cauterized with a Paquelin's cautery. The abdomen was closed in layers with discontinuous sutures.

3. Cancer of the Stomach.—(*Operation 9.40 to 11.*) The patient was a tailor, age 64. Eighteen months ago he had discomfort in the stomach, which was relieved by food. He was treated medically for three weeks and felt better. He continued work until six weeks ago, when he again had dyspepsia and loss of appetite. He has no nausea or vomiting. He has a sensation of fullness one or two hours after meals; he has a disgust for meat. He thinks he has lost weight during the past three weeks.

Physical Examination.—The abdomen is retracted. The liver margin can be felt 2 in. below the right costal margin. There is a large tumour palpable on the right side of the abdomen, which does not move on respiration but can be differentiated from the liver. Gastric analysis shows free acid to be present, and a total acidity of 42; no bile, no lactic acid, and no blood is present. Occult blood is present in the stools. X rays show a small residue after four hours. The shape of the stomach is like a hook.

Operation.—Under general anaesthesia the abdomen was opened in the middle line. There was a large cancer of the pyloric end of the stomach, which owing to the fixity was deemed to be inoperable. The liver had no metastatic growths present. The operation performed was a 'pyloric exclusion'. The stomach was divided into a proximal and distal portion, the latter including as much of the lesser curvature and the glands as possible. The distal

portion was then closed and the proximal portion attached to the jejunum, which was brought up through the transverse mesocolon, as in a Polya operation.

Professor Clairmont considers 'pyloric exelusion' a better operation than a palliative gastrojejunostomy. Vomiting is delayed for a longer period. No complete statistics could be given as to the prolongation of life, etc., in this operation as compared with the prolongation after gastrojejunostomy.

A case of obturator dislocation of the hip-joint having been admitted, this was then reduced under a general anæsthetic. There was no difficulty in the reduction. The skiagram of the dislocated hip was excellent.

4. Enlargement of the Prostate.—(Operation 11.30 to 12.15.) The patient, age 68, was quite well up to six weeks ago, and had never had difficulty with micturition. He first had retention after drinking a quantity of cold water, and had to be admitted to the Inselspital at Berne. He was catheterized for a fortnight while in hospital, and then a catheter was tied in, the bladder being washed out twice each day. After a week he was transferred to the Kantonspital at Zurich on Aug. 25, 1924.

On admission the bladder was distended and contained 700 c.c. of turbid urine. The urine contained pus and blood, and was infected with *Bacillus coli communis*.

Cystoscopic Examination.—This shows a shallow post-prostatic pouch. The urethral orifices are normal, but between them is a small tumour the size of a cherry (adenoma of subtrigonal glands). The mucosa of the bladder is swollen, blood-vessels are not clear, and some trabeculation is present. The kidney function as indicated by test is normal. Blood nitrogen is normal. Wassermann reaction is negative.

The pre-operative treatment has been carried out by tying in a catheter and giving urotropine by the mouth. The anæsthesia was by tropococaine ($1\frac{1}{2}$ c.c. of 5 per cent solution) by the spinal route.

Operation.—The bladder was opened suprapubically and the contents were siphoned off. After trying for half an hour to shell out the prostate with the finger, some 'bands' had to be divided with scissors. The tumour then shelled out easily. A two-way tube was put into the bladder and the latter stitched tightly round it.

The after-treatment consists of continuous irrigation of the bladder for twenty-four hours with iced potassium permanganate solution. No catheter is passed at any time unless there is difficulty in micturition.

5. Tuberculous Osteitis of Symphysis Pubis, with Sinus Formation and Mixed Infection with the *Staphylococcus aureus*.—(Operation 12.30 to 1.10.) The patient was a woman, age 28, who had been admitted on Sept. 3, 1924. In 1919 she had had tuberculous glands of the left side of the neck, and treatment with X rays had given very good results. Four weeks before admission she had complained of pain and swelling in the pubic region, more especially on the right side. She continued her work, but at the end of August she consulted a doctor, who tapped the swelling and removed a glassful of brown pus. During the last few days the swelling has increased in size and become painful. A discharge of pus has occurred at the site of the puncture wound. There has recently been pyrexia and a feeling

of illness, but no pain or frequency of micturition. The bowels have been regular.

Physical Examination.--The skin over the lower part of the abdomen is tender and oedematous. There is a rounded, reddened swelling over the mons veneris, from the middle of which pus is oozing from a sinus. The genitalia are normal. The urine contains leucocytes but no micro-organisms. No tubercle bacilli have been found even after animal inoculation. The Wassermann reaction is negative. Culture of the pus from the sinus shows *Staphylococcus albus*. X rays show a tuberculous osteitis of the symphysis pubis with sequestrum formation.

Operation.--Operation was directed towards the radical excision of the whole of the infected area. This involved a wide excision of the soft parts and the right half of the symphysis pubis.

The procedure was criticized by those present as being unnecessarily drastic, and it was suggested that sequestrectomy alone would have been sufficient. Professor Clairmont disagreed, and stated that in his experience only the widest possible excision of the disease was sufficient. He admitted that it would be a long time before the patient could walk, and probably a special support to the pelvis would always have to be worn.

During the morning a demonstration of the method of blood transfusion employed in the Clinic was given by Dr. Ochsner. Dr. Ochsner, who was from Chicago, had been working in Professor Clairmont's Clinic for a year, while one of Professor Clairmont's assistants had been exchanged for him and was working in Professor Ochsner's Clinic in Chicago.

The method employed was that of Percy as used in Professor Ochsner's Clinic in Chicago. It consists of giving whole blood by means of Kimpton's tube. All patients have their blood grouped before operation. The donors are obtained from patients in the wards suffering from fractures or similar disabilities. These cases are all grouped. There is a list of suitable donors put up in the theatre each day; consequently, if an emergency transfusion is required, it can be done at once. There is no difficulty in getting donors. After the transfusion the donors are put on extra diet with wine, etc. No fee is paid to them in money.

In the afternoon cases were demonstrated in the wards, and then a tour of the new Dermatological Institute of Zurich was made under the guidance of the Director, Professor Bruno Bloch.

This Institute has just been built and equipped at a cost of £100,000. Before the money was spent, the Government took a referendum of the people as to whether they thought it justifiable to spend so much money on such an Institute. Professor Bloch himself went round the towns and villages lecturing. He demonstrated to all classes the necessity of having in their midst a thoroughly up-to-date Dermatological Institute and Clinic. He illustrated his lectures with the beautiful wax models he has in the Institute. These faithfully portray the most important and common skin diseases, particularly those due to syphilis. The referendum gave a large majority in favour of spending this amount of money.

The Clinic contains 110 beds, and is probably one of the most completely

equipped of its kind in the world. There is a special department for the treatment of scabies, any case of which Professor Bloch stated he could cure in two hours. The police bring up most of these cases. The laboratories are very complete, consisting of histological, bacteriological, and chemical departments. There is a special fungus department, and of course a radiological department; the whole Institute possesses 130 mgrm. of radium element.

Many experiments on animals are performed, and some of the results of exposure of rabbits to X rays, and mice to tar inunction, were shown. The rabbits develop epithelioma of the ear after exposure twice a week for about two years. The epithelioma is fatal by producing general metastases in the lung and elsewhere. The mice are affected with cancer in two or three months "if the tar is good". The method adopted is to paint the abdominal wall with tar solution twice a week.

Research work appeared to be progressing actively in all departments of the Institute. All the work witnessed at Zurich can only be regarded as most thorough and painstaking. No effort is spared in arriving at a correct diagnosis. There is a striking spirit of camaraderie and enthusiasm between the Professor and his assistants which can be felt to permeate the whole of the Clinic.

*SHORT NOTES OF
RARE OR OBSCURE CASES*

**A CASE OF
GALL-STONES WITH A GUMMA OF THE LIVER MISTAKEN
FOR MALIGNANT DISEASE OF THE GALL-BLADDER.**

By CECIL P. G. WAKELEY, LONDON.

THE following case is of interest because there was nothing in the family or clinical history to suggest a syphilitic lesion of the liver. The growth in the liver was very hard and was adherent to the gall-bladder, which contained numerous stones: a diagnosis of malignant gall-bladder seemed justified, as no primary lesion could be discovered in the abdomen. Had the gall-bladder and the growth not been removed, but the abdomen closed without further surgical interference, the case would have been labelled malignant and a gloomy prognosis given. The patient would no doubt have recovered, and might easily have stated that the cancer had been cured by some faith-healing device or by some special cancer cure.

It is in such ways that the cancer-cure statistics may be very fallacious. This case also shows the importance of a routine Wassermann reaction being performed, for had a positive reaction been returned before instead of after the operation, excision of the gumma would probably not have been performed.

The history of the case was as follows: Mrs. M. A. T., age 43, came up to the out-patient department of King's College Hospital in March, 1924, complaining of pain referred to the right side of the abdomen which radiated through to the back. The pain commenced in September, 1923, and had gradually become worse, so that the patient was kept awake at night. The pain was more acute at some times than others, and on two occasions the patient had vomited. The pain had no relation to food, although she thought that her trouble was indigestion, and it was treated as such by her doctor.

The patient was married and had two children, both of whom were healthy girls. No history of miscarriage. Her periods were regular and normal. On examination, the abdomen moved well on respiration; the liver was found to be slightly enlarged, being about an inch and a half below the costal margin. A hard, tense swelling could be palpated just below the ninth costal margin; it was tender to the touch. No other abnormality could be palpated in the abdomen. The case was diagnosed as one of gall-stones, and operation was advised. On May 30, a laparotomy was performed under gas and oxygen anaesthesia; a supra-umbilical incision was made just to the right of the middle line, the rectus muscle was exposed and drawn outwards. On opening the

peritoneal cavity, the gall-bladder was exposed; it was found to be enlarged, thickened, and contained several stones. Just to the right of the gall-bladder a hard lump projected from the under surface of the liver, which appeared to be attached to the gall-bladder. There was no perihepatitis in the region of the tumour, and a diagnosis of carcinoma of the gall-bladder was made. The stomach, intestines, and pancreas showed no sign of abnormality; in fact, the abdomen seemed to be quite normal with the exception of the gall-bladder and liver.

It was decided to remove the gall-bladder together with the tumour in the liver. The lower end of the cystic duct was divided between clamps and the cystic artery secured. The lump in the liver was completely excised by means of a diathermy cautery knife. There was very little bleeding. After excision of the tumour in the liver, the raw area was packed lightly with white gauze and the abdomen closed. The gauze plugging was removed after two days, a small piece of corrugated rubber drainage tubing being inserted

instead. This was removed on the sixth day as there was no discharge. The wound healed quickly and convalescence was uneventful, the patient losing all her pain.

On section of the excised portion of the liver, one large and two smaller hard white areas were seen (Fig. 367). The larger one approached up to the margin of the liver. The gall-bladder was very thickened and contained numerous stones. Several sections were taken from different



FIG. 367.—Specimen showing excised portion of liver with the gall-bladder.

parts of the excised portion of the liver for microscopical examination: the pathologist was asked to report if malignant disease was present. The report was as follows:—

The sections present the typical appearance of a gumma of the liver. The sections from the mass of the gumma showed areas of coagulation necrosis, surrounded by syphilitic granulation tissue in which were a few giant-cells. The sections from the surrounding liver tissue showed a marked perivascular infiltration with lymphocytes.

After receiving the pathologist's report, a Wassermann reaction was performed and was reported as strongly positive. Antisymphilitic treatment was commenced before the patient left hospital and has been continued since. The patient has completely lost all her pain, and has put on half a stone in weight since leaving hospital.

LOOSE BODIES IN THE ANKLE-JOINT.

BY GEORGE H. STEVENSON, GLASGOW.

THE patient, a man, age 22, was admitted to my wards at Bellahouston Hospital early in May, 1924.

HISTORY.—While on military service in India during November, 1920, he fell when running down a hill and twisted his right ankle. The injury was not considered serious enough at that time to necessitate his admission to hospital and he was treated by his regimental medical officer. The joint has remained painful from that time onwards, and he states that the initial swelling had never completely disappeared. Recently a 'lump' on the inner

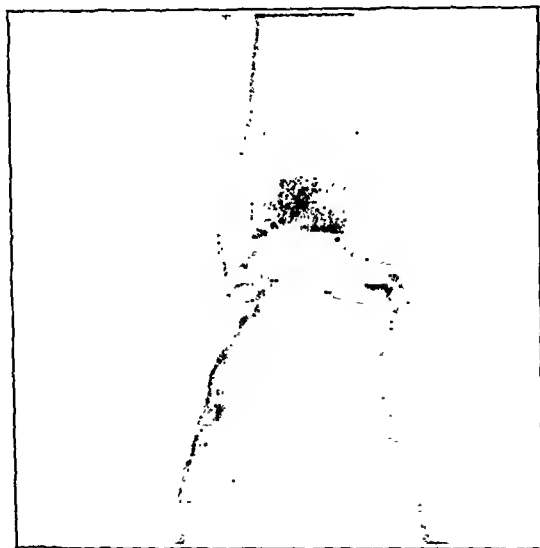


FIG. 368.—Antero-posterior view of ankle-joint, showing size and position of loose body.

side of the joint had been troubling him, and this had apparently been growing larger.

EXAMINATION.—There was a hard swelling below and behind the internal malleolus of the right ankle. The swelling appeared to extend upwards under the malleolus, and was painless on pressure. All movements of the joint were quite free and there was no sensation of grating. All the other joints appeared quite normal. X-ray examination showed a large shadow (Figs. 368 and 369) in the region previously indicated, having the characteristic 'ghostlike' appearance associated with loose bodies in the knee and elsewhere.

OPERATION.—A J-shaped incision was made over the swelling posterior to the internal malleolus, and the tendons of the tibialis posticus and

flexor longus digitorum, together with the posterior tibial nerve and artery, were retracted backwards after division of the internal lateral ligament. The capsule of the joint was then opened, and a large loose body was easily extracted, followed by a second of much smaller size. The loose bodies had apparently gradually distended the small sac of synovial membrane found in this region.

On removal, the larger of the two bodies measured $1 \times \frac{3}{4}$ in., the approximate size and structure being well illustrated by the X-ray photograph (*Fig. 370*). The smaller body was slightly larger than a pea.



FIG. 369.—Lateral view of ankle-joint, showing loose body.



FIG. 370.—Radiograph showing approximate size and texture of the larger loose body.

I cannot find any reference to loose bodies in the ankle-joint in the literature at my disposal, and none of my colleagues can remember having seen a similar case. Loose bodies occur commonly in other joints, but it seems remarkable that a body of the size described should have been able to form in a joint having the comparatively strict limitations of the ankle, and it is for this reason I put the case on record.

I am indebted to Dr. Henderson and Mr. Livesy for the excellent X-ray photographs, and to the Ministry of Pensions for permission to publish the case.

STRANGULATED HERNIA THROUGH THE FORAMEN OF WINSLOW.

By W. G. McKENZIE AND DUNCAN WOOD. Bristol.

THE following case is of interest from its rarity and for comparison with other reported cases.

The case was that of a man, age 59, previously healthy, who had not suffered from indigestion. He first complained of discomfort, which rapidly passed to definite and constant pain, immediately after the midday meal. The bowels had been open that morning. There was no vomiting. He was first seen two hours later.

On examination, the abdomen moved freely; there was little or no tenderness on palpation, but it was slightly tympanitic to percussion: pulse and temperature were normal.

The following morning, i.e., seventeen hours after onset, pain was more severe, and localized to the epigastrium; there was definite abdominal distention, tenderness on deep palpation in the epigastrium, no rigidity: pulse and temperature were normal. No vomiting, no passage of faeces or flatus to turpentine enemata.

Twenty-four hours after onset the pulse was 120, the tongue clean, and there was no vomiting; the abdomen was distended in the neighbourhood of the umbilicus; the upper third of the abdomen was rigid and gave the sensation of a swelling being present; this swelling was resonant to percussion; the normal liver dullness was present.

Operation was performed three hours later. On opening the peritoneal cavity, blood-stained fluid escaped. The stomach and some loops of small intestine were found distended. On drawing the stomach downwards, a large black swelling was seen to be pushing forwards the gastro-hepatic omentum. The latter was thin, and easily split, showing strangulated loops of small intestine lying in the lesser sac. On tracing back the strangulated loop, it was found to be entering the lesser sac through the foramen of Winslow (Fig. 371). This foramen was dilated further with the finger, and the strangulated loops partly pushed and partly drawn through the foramen out of the lesser sac. The released gut did not revive, thrombosis having

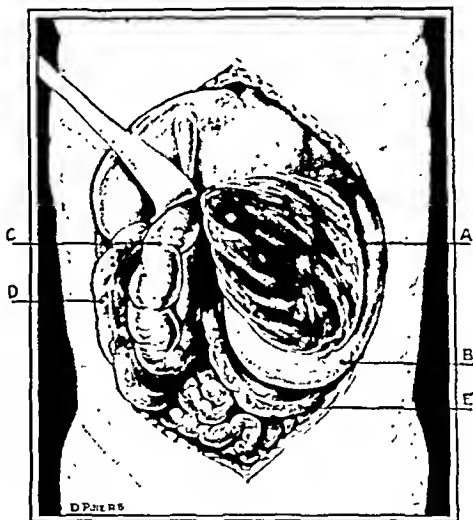


FIG. 371.—Hernia into foramen of Winslow. A, Gangrenous loops of jejunum in lesser sac; B, Stomach pushed downwards; C, Dilated loop of small intestine entering foramen of Winslow; D, Collapsed ascending colon; E, Transverse colon pushed downwards.

already taken place. Forty inches of small intestine were resected and an end-to-end anastomosis was done. Owing to the serious condition of the patient, no attempt was made to close the foramen of Winslow or the gastro-hepatic omentum.

Abdominal distention persisted after the operation in spite of pituitary injections and repeated turpentine enemata. Death occurred from paralytic ileus on the third day after operation and the fifth day of the disease.

The following points are of interest:—

1. Onset after a midday meal in a previously healthy individual is similar to the cases of Elliot¹ and of Treves.² The rate of onset appears to vary considerably. In Haw's³ case the history was only half an hour, death being apparently due to shock from the large amount of bowel strangulated. In Rawlence's⁴ case operation was not called for before the sixteenth day.

2. The absence of vomiting before operation in a small-gut obstruction was a marked feature. In Treves's case vomiting did not start until the second day, and was then only slight in amount. In Rawlence's case vomiting commenced on the thirteenth day. This may possibly be explained by the distended coils round the foramen of Winslow pressing on the pylorus and preventing regurgitation of the duodenal contents into the stomach.

3. Operation. Authorities differ as to the best method of reducing the strangulated loop. Moynihan⁵ recommends opening the lesser sac through the gastro-hepatic or gastrocolic omentum, and then reducing the strangulated loop; or, if this is found to be difficult, to do a temporary enterotomy first, after which, having emptied the contents of the loop, reduction will be possible.

If the damaged gut is too friable for manipulation, a portion of adjacent healthy gut could be drawn into the lesser sac through the foramen, and the loop resected *in situ*. Jeanbrau and Riche⁶ advise enlarging the foramen of Winslow by incising the peritoneum forming the anterior lamina of the gastro-hepatic omentum as in exposing the common bile-duct. This, whilst easy in the post-mortem room, would have been extremely difficult in the present case on account of the pressure of the dilated small intestine obscuring the foramen. Treves, in the account of his case, states that the presence of distended coils of intestine in the vicinity of the opening rendered the demonstration of the relations very difficult.

In the authors' case the strangulated loop when released could be drawn well outside the abdominal cavity for excision. The resected loop was jejunum; no abnormality of the colon was noticed.

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² TREVES, *Lancet*, 1888, Oct.

³ HAW, *Lancet*, 1909, i, 1598.

⁴ RAWLENCE, *Jour. R.A.M.C.*, 1918, xxx, 332.

⁵ MOYNIHAN, *Retroperitoneal Hernia*, 1906.

⁶ JEANBRAU and RICHE, *Rev. de Chir.*, 1906, No. 4.

A CASE OF MYOMA OF THE STOMACH WITH GASTRODUODENAL INTUSSUSCEPTION.⁵

BY L. E. BARNETT, DENEIDIN.

MYOMA of the stomach is regarded as the most common non-malignant tumour occurring in this situation. Many of the cases recorded were complicated by some degree of intussusception, and the following case is an example of an extreme degree of that remarkable condition.

W. S., age 54, a powerfully-built farmer and stock dealer, was referred to me by Dr. P. Gow, of Milton, Otago, in February, 1924, with the provisional diagnosis of carcinoma of the stomach. He had been suffering for two years from gastric pains, vomiting, and occasional hæmorrhage, with loss of weight and increasing weakness. A firm, rounded mass the size of a goose's egg was sometimes palpable, sometimes not, in the right hypochondrium. Gastric analysis indicated the presence of much mucus and blood and slight diminution in hydrochloric acid.

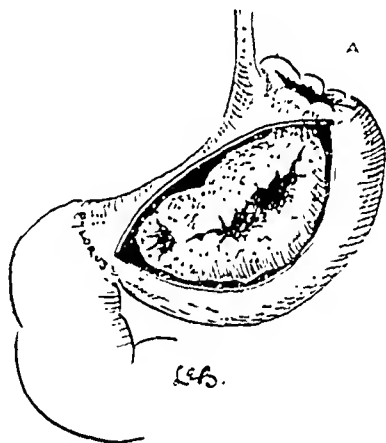


FIG. 372.—Diagrammatic sketch showing tumour as seen when stomach was opened. A, Intussusception beginning.

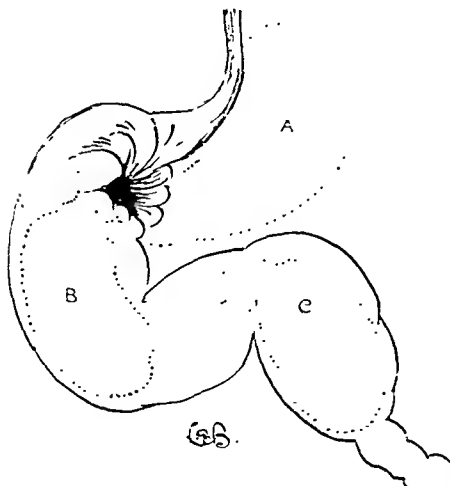


FIG. 373.—A, Stomach intussuscepting; B, Tumour as felt in duodenum; C, Tumour as felt in jejunum.

X-ray examination showed only dilatation and some stasis.

Operation on Feb. 20, 1924, revealed the presence of a large oval mass inside the hugely distended duodenum. By manipulation this mass could be pushed onwards through the whole length of the duodenum, and for a distance of 20 cm. into the jejunum. It could also be easily manipulated back into the stomach, and on investigation it was found to be a tumour attached by a pedicle 2 cm. in diameter to the cardiac end of the stomach, in close proximity to the œsophageal opening. Its extraordinary freedom of movement was permitted by an unusual

degree of intussusception of the fundus of the stomach. The illustrations (Figs. 372 to 376) give a better idea of the condition than any written description could do.

The stomach was freely opened and the tumour cut away from its attachment without difficulty. The part of the stomach wall involved in the process of intussusception was of a peculiar leathery consistence, due, no doubt, to chronic fibrosis. The tumour itself showed two deep crateriform

ulcers. A similar appearance is figured in other cases of gastric myoma that have been published.

The patient made an uneventful recovery and rapidly regained his former weight and robust appearance.

The report of Dr. P. P. Lynch, Clinical Pathologist to the University of Otago, is as follows:—

"Tumour was roughly ovoid—12 cm. by 6 cm. by 5 cm. At its upper and posterior part there was a pedicle 2 cm. in diameter. Its anterior aspect was excavated,

showing an irregular cavity with narrow elongated opening and ragged, overhanging edges. The surface of the tumour was covered by epithelium derived from stomach. The floor of the excavated portion was lined by granulations only.

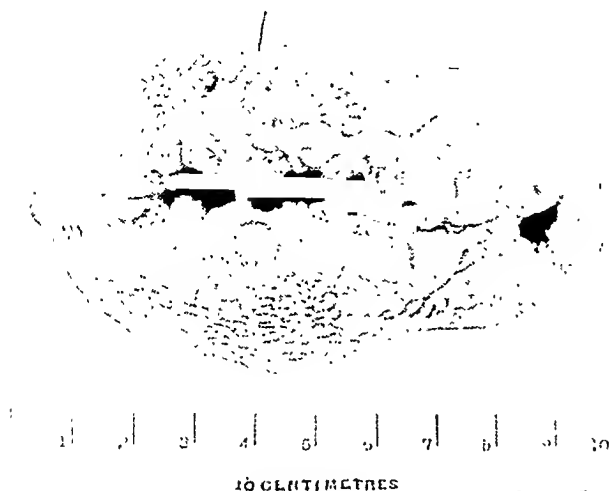


FIG. 374.—Photograph of tumour after removal.



FIG. 375.—Myoma, low power ($\times 11$).

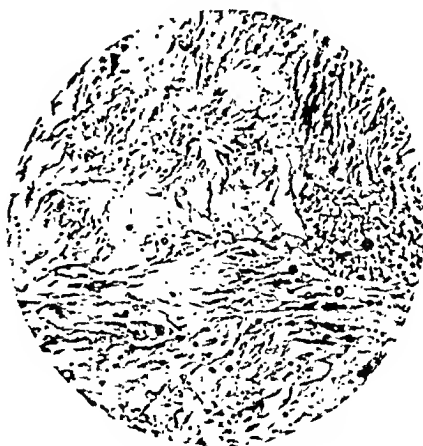


FIG. 376.—Structure of myoma, high power ($\times 150$).

"Microscopic examination of the tumour showed masses of large, smooth muscle cells with well-supported vessels, and in parts many points of

hæmorrhage. The tumour was definitely capsulated, this capsule being formed for the most part by thickened submucosa. It is a myoma with central necrosis and excavation."

An excellent account of benign tumour of the stomach was published in the Mayo Clinic *Transactions* for 1921.

I am indebted to Dr. Lynch and Mr. McKay, of the Pathological Laboratory of the University of Otago, for the sections and photographs.

ADENOMA OF SMALL INTESTINE WITH INTUSSUSCEPTION.

By G. M. KENDALL AND I. W. CORKEY, Epsom.

THE rarity of the condition and the difficulties of diagnosis make the following case worthy of note.

A married woman, age 36, was first seen on April 5, 1921. She complained of attacks of pain with vomiting; she had had a similar but milder illness about a year before. The pain was referred to the upper abdomen and passed round to the back; it was at times relieved by vomiting. She sometimes woke up in the early morning with the pain; there was no distinct connection with the taking of food, but it had on occasion been brought on by a cup of tea. At this time physical examination was completely negative. The bowels were not constipated. These attacks of pain continued at intervals, but vomiting ceased.

About three weeks later the character of the pain changed and was now felt in the lower dorsal part of the back, and passed round towards the epigastrium. There was no vomiting. The attacks of pain were very severe; the bowels were constipated. At this time, on some days a distended viscus was felt passing across the abdomen just below the umbilicus; this was thought to be the transverse colon, but on May 10 slow peristaltic waves were seen passing from left to right and beginning to the left of and about the level of the umbilicus. The passage of these waves coincided with a spasm of pain, and pressure on the viscus caused similar pain. In the afternoon of May 18 a more severe attack began and persisted; the patient vomited several times during the night; a tumour now became palpable below the umbilicus.

The abdomen was opened on May 19. A recent intussusception was found, three feet in length, situated in the lower part of the ileum but not reaching the ileocecal valve; it was easily reduced. At its apex was a pedunculated tumour of the size of a small tangerine orange; the glands in the mesentery near were moderately enlarged. The piece of gut containing the tumour, and part of the mesentery containing the glands, were excised, and an end-to-end anastomosis was done. The surface of the tumour was necrosed and inflamed.

Dr. J. F. Taylor examined the tumour microscopically, and reported:—

"The tumour is an adenoma, with œdema, congestion, hæmorrhage, and inflammation, evidently from torsion of the pedicle. The glands show chronic inflammation only."

The patient has made a good recovery.

REVIEWS AND NOTICES OF BOOKS.

Lectures on Gonorrhœa in Women and Children. By J. JOHNSTON ABRAHAM, C.B.E., D.S.O., M.A., M.D. (Dub.), F.R.C.S. (Eng.), Surgeon, London Lock Hospital; Senior Surgeon, Kensington General Hospital, etc. Crown 8vo. Pp. 142, with 9 illustrations and 4 plates. 1924. London: William Heinemann (Medical Books) Ltd. 7s. 6d. net.

THIS book supplies a long-felt want, and should be of considerable value to those interested in this particular line of work. In the foreword the author states that his object in publishing the lectures is to interest the general practitioner and to bring to his notice methods of examination and treatment of the disease in its early stages (when it is curable) without the use of any special instruments or skill beyond that possessed by the average practitioner. This, of course, is most commendable, and is an object greatly to be desired, for the majority of women prefer to consult their doctor rather than visit a specialist or attend a venereal clinic. We feel, however, after reading the book, that it will be long before Mr. Abraham's ideals are realized, for there are few practitioners, particularly with panel practices, who can spare the time to learn and carry out the technique so ably set forth. It is unfortunately a notorious fact that gonorrhœa in women is a neglected disease—neglected by the patient, the practitioner, and the gynæcologist; therefore if this book stimulates only a few to practise the methods of examination and treatment advocated, the benefit will be reaped by many. In explaining the methods of examination, the author rightly insists on the dorsal decubitus and on the importance of staining smears taken from the labia, the urethra, the cervical canal, etc.; he also points out the important fact, of which many are unaware, that for legal purposes staining by Gram's method is essential.

The first chapter contains a clear and concise description of the symptoms and treatment of the disease in its acute form, including an excellent account of treatment of vulvitis in children which should be of great value to house officers and others. Stress is laid on the importance of realizing that acute endocervicitis is the commonest symptom of gonorrhœa in the adult female, and that consequently the usual vaginal douche is useless. Of the three varieties of treatment described, the author considers that McDonagh's manganese-contramine method yields the best results.

Chapters 2 and 3 deal with the complications of the urinary and genital tracts. In the former the modern methods of treating cystitis and pyelitis are described, and in the latter the technique and value of ionization and diathermy for chronic endocervicitis are clearly explained.

Gonorrhœal toxæmia, septicæmia, and the important extragenital complications such as synovitis, arthritis, and so on, are described in two chapters on metastatic gonorrhœa. In discussing the treatment, the author, in our opinion very rightly, warns the practitioner against topical treatment of the cervix or uterus during the acute stage of the complication, and advises that it should be deferred for several weeks after the acute symptoms have subsided. "Concentrate on the joints while they are inflamed, and attend to the primary focal lesion afterwards" is sound advice.

The chapters on gonococcal ophthalmia and gonococcal sterility are excellent, and the latter in particular contains much valuable information.

The final chapter, on tests for cure, is perhaps one of the most important in the book, and sets forth very clearly the tests which the author has found to be the most reliable from practical experience.

The book contains several useful illustrations, is clearly written, and amongst its many merits possesses one which should appeal greatly to those for whom it is intended—it is brief and to the point.

Internal Derangements of the Knee-joint: their Pathology and Treatment by Modern Methods. By A. G. TIMBRELL FISHER, M.C., F.R.C.S., late Hunterian Professor, R.C.S. of England, 1921-2; Assistant, Surgical Unit, University College Hospital. Demy 8vo. Pp. 144 - xii, with 80 illustrations. 1924. London: H. K. Lewis & Co. Ltd. 12s. 6d. net.

MR. TIMBRELL FISHER'S book is probably the most complete account of internal derangements of the knee that has been published in English. It is particularly strong on the pathological and anatomical side, and the possible or probable mechanics of injuries of the semilunar cartilage are considered in very great detail.

The author makes much point of the difference in strength of attachment of different portions of the internal semilunar cartilage and their bearing upon injuries. There has been much divergence of opinion upon the importance of the internal lateral ligament in this connection, and discussion whether rupture of this ligament is a necessary concomitant of a lesion of the internal semilunar cartilage. Mr. Timbrell Fisher holds that it is not so, and that, in fact, an intact internal lateral ligament is essential to the production of certain lesions of the cartilage, because the latter is firmly attached to the posterior or short fibres of the ligament, a weak spot existing in the cartilage just in front of this attachment. The mechanism of production of injuries of the cartilage cannot yet be said to be cleared up, but Mr. Fisher has certainly added a new mechanical suggestion, and many clinicians will agree with him that rupture or over-stretching of the internal lateral ligament is not an essential part of a cartilage injury, even though they may not agree that injury commonly starts at the weak spot he has described.

If criticism is here made of certain other aspects of the book, it is rather with the suggestion that in some subsequent edition improvements may be introduced. The clinical side of the book is not quite up to the same standard as the pathological side. Hardly sufficient attention is given to the difficulties of differential diagnosis, more particularly in those cases seen by the surgeon between attacks when the knee is apparently perfectly normal. These cases continue to worry the surgeon, who is obliged to arrive at his diagnosis almost entirely upon the history that he can obtain from the patient. Another important point that might be elaborated is the attempt to make before operation a differential diagnosis of the exact lesion of the cartilage likely to be found. This is more particularly important in lesions of the posterior part of the cartilage, which are not visible through the ordinary anterior incision, and which, when they are suspected, necessitate either a wide anterior incision or the removal of a cartilage, apparently normal in front, in the expectation that the posterior half will be found fractured, or a second exploratory incision in the posterior part of the joint. The latter point—that is, the second incision over the posterior part of the cartilage—now not uncommonly adopted by surgeons, is omitted from the book altogether.

Mr. Fisher's patella-displacing operation is a very valuable one for complicated and difficult explorations of the knee-joint; it has undoubted advantages over the patella-splitting method and does less eventual damage to the knee-joint.

Keeping to the clinical side: after a displacement of the cartilage with locking of the knee which has been reduced by manipulation, rest for fourteen days with massage and graduated exercises is recommended. Theoretically this sounds a rational method, but at the same time Mr. Fisher, as the result of his pathological investigations, seems to have come to the conclusion that a split cartilage does not unite. If this is so, there appears to be no reason for maintaining this period of rest, and it seems agreed that in many cases a knee which has been completely locked, reduced by manipulation, and used forthwith, remains permanently free from any subsequent derangement. The question of what actually happens when a displaced cartilage is reduced is a very important one. Is the cartilage in most cases really restored to its normal position: or is it pushed into some other position in which it gives no trouble; or is it further fractured, so that the free ends no longer get into the way in movements of the joint? If rest is to be advocated in order to try to get healing, fourteen days seems to be too short a time. Six weeks or longer should be necessary on pathological grounds, yet recurrence of displacement undoubtedly occurs after quite long periods of splinting.

There is, of course, much included in the book besides injuries of the semilunar cartilage. Mr. Fisher's work on loose bodies is so well known already that it hardly requires mention. It is briefly recapitulated here in so far as it concerns the subject. The book is very profusely illustrated; the illustrations are exceedingly well reproduced and very appropriate to the subject-matter. It is a book which ought to be in the hands of every operating surgeon who ever opens a knee-joint, and it is to be hoped that in due course, as the result of further experience and consideration, Mr. Fisher will produce a second edition which will give still greater clinical assistance.

Minor Surgery and Bandaging. By GWYNNE WILLIAMS, M.S., F.R.C.S., Surgeon, University College Hospital. Crown 8vo. Pp. 423 + viii, with 239 illustrations. 1924. London: J. & A. Churchill. 10s. 6d. net.

THIS is the eighteenth edition of Heath's *Minor Surgery and Bandaging*. Whilst intended for the use of house surgeons, dressers, and junior practitioners, it is such a storehouse of practical 'tips' and suggestions that it will prove of great value to the experienced surgeon. It provides an excellent and safe bridge over the great gap between the time of qualification—a time of, perhaps, great theoretical knowledge, but very little wisdom in actually dealing with patients—and the time of having become an experienced house surgeon. It serves, too, as an invaluable guide for students on first working in the surgical department of their hospital.

The book has been ably revised and brought up to date, and there is no modern technique in general use without mention or description. The chapters on fractures are particularly good. In spite of the introduction of much new matter, the careful pruning of obsolete methods, together with the use of thin paper, render the volume of convenient size. The general arrangement and illustrations are excellent, and the index is particularly good and clearly arranged.

The Science and Art of Anæsthesia. By Colonel WILLIAM WEBSTER, D.S.O., M.D., C.M., Professor of Anesthesiology, University of Manitoba Medical School. Royal 8vo. Pp. 214, with 37 illustrations. London: Henry Kimpton. 24s. net.

THIS book aims at being a concise manual for the occasional anaesthetist, and, although a short work, it is, on the whole, fairly comprehensive. As would be expected, ether and nitrous oxide and their combinations are the most completely described, with the latest methods and machines for their use. Chloroform is very briefly discussed, although, in this country at least, it is probable that it is still the routine anaesthetic in use for the smaller operations in general practice. The physiology of anaesthesia is very well described, and sound advice is given in the chapters on the selection of the anaesthetic and on the nature of the operation. Surgical shock and the various necessities before and after operation are also well but briefly described.

It is an interesting and readable book, and very well got up, but the price, twenty-four shillings, appears a little large for what the author admits should be supplemented by larger text-books.

Chirurgie de l'Oreille, du Nez, et du Pharynx. By Dr. GEORGES LAURENS. 2nd edition, entirely revised. Royal 8vo. Pp. 1052, with 733 illustrations. 1924. Paris: Masson et Cie. Fr. 100.

IT may be said at once that this work of 1052 pages is the best which has appeared on the subjects with which it deals. This eulogium holds good whether it is applied to the excellent illustrations, of which there are 792, to the paper and type, and above all to the wisdom and fine judgement which the author has brought to the fulfilment of his task.

It will be a most helpful volume to all teachers of oto-rhino-laryngology, and of priceless value to senior clinical assistants and those about to confine themselves to these branches of surgery. These will do well to read again and again the "General Considerations", which occupy fifty-seven pages and deal with such important

subjects as the best type of installations, sterilization of the field of operation, instruments, and hands, and general and local anæsthesia; the latter is greatly favoured in France, and consequently its technique has been highly perfected. We are not acquainted with a better account than the author presents of the principles of radio-therapy (including X rays), and of the attempt to classify the histological structure of tumours according to their radio-sensibility. The reasons given for choosing radium or X rays for different circumstances are obviously the result of prolonged experience.

With regard to all the operations described an excellent plan is followed. Each procedure is described with its indications, technique, and results. The contra-indications for intervention are clearly stated.

Under surgery of the ear the statement (p. 65) that the operations of aural surgery, major and minor, may be performed under local anæsthesia, although a general anæsthetic is *justifiable* in resection of the mastoid for tumours, for labyrinthine disease, and cerebral abscess, will scarcely receive assent in this country, where the art of general anæsthesia is so highly developed. On the other hand, a conscientious student of Dr. Laurens' work will certainly gain the impression that English-speaking nations would do well to exploit to a much greater degree the possibilities of local or regional anæsthesia as induced by a mixture of novocain and adrenalin.

The various accidents and difficulties met with in the mastoid operation are well described and illustrated, and valuable hints given as to avoiding or overcoming them. Among these may be mentioned the wounding of the facial nerve, the lateral sinus, and the external semicircular canal. The author warns against deliberate denudation in radical operations on the mastoid unless there are definite indications for doing so. He thinks that non-observance of this rule may be the explanation of certain cases of chronic headache which follow the operation. In operations where the lateral sinus is infected, he states that statistics show an equal number of cures whether the jugular be tied or the sinus alone dealt with.

The operative treatment of labyrinthitis and of facial paralysis, the cerebral complications of otogenic origin, and tumours of the ponto-cerebellar angle are models of clear exposition and wise judgement.

Rhinologists will agree with the stress laid by the author on meddlesome interference after endonasal operations instead of allowing the wounds rest and natural progress towards cure (p. 383). In the treatment of intractable epistaxis we are surprised that no mention is made of the value of submucous resection of the deviated septum as a method for relieving the stretched mucosa in which the thin-walled vessel is often found to be situated. The surgical treatment of 'ozæna' is recommended, and consists in narrowing the nasal fossæ by forcing inwards the inner walls of the maxillary sinuses. Ramadier's procedure is described in detail. The description and illustrations of the surgical treatment of the diseases of the nasal sinuses could scarcely be improved upon. Local or regional anæsthesia is advocated, and the hints on after-treatment should be read by every rhinologist.

Space will not permit a review of the author's views with regard to general anæsthesia for the removal of adenoids. Whenever any general anæsthetic is administered, "the fatal dose may approach the useful dose, the precipice skirts the road . . ." He considers tonsillectomy a good operation in the general run of cases, and insists that there is no need to have recourse to a "veritable glandular castration", especially in young subjects. Considerable space is devoted to hæmorrhage following tonsil enucleation. It would have been well if the distinguished author had emphasized the necessity of ligaturing the tonsillar branch of the posterior palatine artery in every case. Post-operative bleeding would then be a very rare occurrence. He rightly describes galvano-cauterization of the tonsil as likely to "enclose the wolf in the sheepfold".

The chapters on the larynx and trachea, including endoscopy of these regions and the œsophagus, reach the same high standard as those which precede them. The major operations for malignant disease of the larynx and lower pharynx are beautifully illustrated, and the advantages of carrying them out under local anæsthesia are strongly urged and almost refute adverse criticism.

Collected Papers of the Mayo Clinic. Edited by Mrs. M. H. MELLISH. Vol. XIV. 1922. Royal 8vo. Pp. 1394, with illustrations. 1923. London and Philadelphia: W. B. Saunders Co. Ltd. 63s. net.

THE most weighty of the papers in this volume are those of which W. R. Meeker seems to be the inspiration, alone or with others, on "Paravertebral Nerve-block Anæsthesia". These enter fully into the indications for, and the technique of, this procedure in the different regions of the spine; but the indications for, and advantages of, trans-sacral nerve-block anæsthesia as compared with novocain spinal analgesia would be helpful. As the author of one of these papers admits, trans-sacral nerve-blocking usually requires a general anæsthetic and involves a delay of fifteen minutes. This comparison will not apply, of course, in the surgery of the chest or neck, where most of us do not follow Jonnesco in his advocacy of spinal analgesia.

Adson contributes two papers on "Removal of Tumours of the Spinal Cord" and "The Radical Treatment of Trifacial Neuralgia", both beautifully illustrated. Does the author underestimate the difficulties of approach to the Gasserian ganglion owing to variations of the middle meningeal artery? If he has met with such difficulties, it would surely be helpful to advise his readers how to deal with them.

J. C. Masson deals with "Post-operative Ventral Hernia" on sound lines. In his description of the technique for closure of such defects we think he does not sufficiently emphasize the importance of free excision of all scar tissue and approximation of healthy fibrous layers—for we do not attach any importance to muscle approximation, to which he allots a separate heading as an important point. We regret that he should make reference to the use of fascial transplants as advocated by Gallie and Le Mesurier, which for the purpose under discussion is surely unnecessary and clumsy.

Two papers by C. H. Mayo and Judd show the value of ileostomy for the removal of acute obstruction and as a safety-valve for resection of the colon, though in the latter instance we are not convinced that it is preferable to cæcostomy.

Every surgeon interested in the thyroid problem must at frequent intervals take steps to maintain his surgical sanity by reference to papers on the pathology of excess and diminution of this gland's activity, for there is scarcely any field in which it is more easy to do bad work unless in every case indications for surgery are based on a sound pathology. We feel, therefore, that the brief extract of Dr. L. B. Wilson's paper on "Hypertthyroidism" is well timed and well worth digestion, as are all his papers on this question.

H. I. Lillie's warning that earache is not necessarily of aural origin is one that cannot be repeated too often, and the same author's paper on "Infection of the Lateral Sinus" is valuable because he is able to include nineteen cases of this rare complication of mastoid disease. We are glad to find that he holds a very open mind on the value of ligation of the jugular vein.

Collected Papers of the Mayo Clinic. Edited by Mrs. M. H. MELLISH. Vol. XV. 1923. Royal 8vo. Pp. 1377, with 410 illustrations. 1924. London and Philadelphia: W. B. Saunders Co. Ltd. 63s. net.

THE Editorial Committee of the Mayo Clinic are to be congratulated on having the courage to change their policy with regard to the publication of the collected papers of the Clinic. Originally it had been intended that the volumes should contain reprints of all papers issued during the year, but the material has so much increased that this was found impossible. In the volume under review many articles without clinical interest appear only by title, and many more in the briefest possible abstract. It may be argued that it is extremely difficult to select for exclusion papers on researches which indirectly may prove to be of great clinical importance, and some of the abstracts are so terse as to be almost indigestible; but the net result of the change is satisfactory, for the volume is more comprehensive and is much more easily handled than those published in the last few years.

If no fact of great significance has yet emerged from the numerous papers on experimental work in connection with the formation of gastric and duodenal ulcers, yet many of the conclusions or hypotheses which have resulted from these studies are in the highest degree suggestive. We are therefore glad to see a further paper by Professor Mann, which shows that diversion of the secretions which neutralize the gastric acid, either by duodenectomy or transplantation of the ducts, results in the formation of typical ulceration.

The reprint of Dr. C. H. Mayo's paper on gastroduodenostomy will be that for which most surgeons will consult this volume, and it is to be hoped that the method suggested indicates a return to more rational and less mutilating surgery for limited and innocent lesions of the stomach and duodenum.

Dr. New reports 107 cases of actinomycosis, but it is unfortunate that the paper loses its general clinical value by being confined to observations of the disease as it affects the head and neck. It has long been recognized that superficial or peripheral actinomycotic lesions yielded to various treatments: but when the abdomen or chest is involved, the prognosis in our experience is very grave, and it would have been valuable to learn from the general experience of the Mayo Clinic whether their statistics show that there is any improvement in this class of case.

Etude du Syndrome douloureux du Côlon proximal. By Dr. OSCAR MERCIER, of the Faculté de Médecine de Paris. Royat 8vo. Pp. 248. Illustrated. 1921. Paris: Amédée Legrand.

The literary form of a medical thesis is a convention of almost universal acceptance: the contention to be maintained, its past history and development, its anatomical, physiological, and pathological aspects, its relationship to other authorities friendly and inimical, and the final addendum of clinical material, more or less second-hand, as the foundation upon which the superstructure has been reared—these are its constant ingredients. In France apparently there is the added grace of a dedication—in this instance to twelve people specifically named, in addition to "mes maîtres de la Faculté de Médecine de l'Université de Montréal".

"Dans ce travail nous limitons notre étude à la constipation résultant d'un état morbide du côlon droit" is the opening sentence of this work—an admirable *motif* that becomes obscured later on amidst most of the ills that flesh is heir to. The reader is not spared "les troubles du système neuro-végétatif", "les déséquilibres du système chromaffin", "vagotonisme", and "les déséquilibres des glandes endocrines". Little more need be written to indicate the general tenor of the work. A deplorable confusion between the cæcum and the right colon pervades the book from beginning to end; in fact, very little at all is said about the colon, and "which is which one can never make out"! An operation always alluded to as "cæco-transversostomie", recommended and designed by Professor Desmarest, whose cases form the basis of the thesis, is illustrated by a sketch in which "colo-colostomie" is being performed obviously. This was done upon 9 patients out of the total series of 55, with the result that in 6 of them "la constipation persiste entréecarpée de débâcle diarrhéique". Upon 16 others Friedrich's old-fashioned operation of hemicolectomy was performed, of whom 1 died, 3 were unrelieved, and 1 was too recent to be classified as a result. The remaining 30 cases were treated solely by the removal of the appendix and the resection of an anomalous group of tie-bands. In 11 of these no improvement followed the operation, in 4 there was slight improvement, whilst in the remaining 15 cases in which success was achieved it is stated that gross disease of the appendix obvious to the unaided eye and confirmed by microscopical investigation was present.

The "syndrome douloureux du côlon proximal" is not recognized easily amongst these cases. The views and experiences of Grégoire, Duval, Roux, and Wilms of the value of fixation of the proximal colon are lightly brushed aside—a mental attitude of the inexperienced that presents a not unfamiliar aspect—whilst Mercier's experience of his own methods summarized above seems to afford but exiguous evidence upon which to base any conclusion about anything. No doubt a grateful

Alma Mater will have added already this work to her 'archives des Thèses', whence within but a short time the dust of the poppy of oblivion will be but lightly stirred by the plumed brush of the library attendant. And, after all, why not? "Où sont les thèses d'autant?"

The Theory and Practice of the Steinach Operation: with a Report of 100 Cases. By DR. PETER SCHMIDT (Berlin). Translated by DR. M. D. EDER, and with an Introduction to the English Edition by J. JOHNSTON ABRAHAM, C.B.E., D.S.O., M.A., M.D. (Dub.), F.R.C.S. (Eng.). Crown 8vo. Pp. 150 + xiv. 1924. London: William Heinemann (Medical Books) Ltd. 7s. 6d. net.

PROFESSOR EUGEN STEINACH is a biologist and laboratory worker of Vienna. He has been reflecting and experimenting for several decades. Steinach's work has nothing in common with that of Voronoff. His original results obtained by vasoligation in old rats are sufficiently striking. After the vasa had been tied in decrepit old rats, the animals took on a new lease of life; the fur grew again, they put on fat, and became agile and pugnacious. Obviously in some way the factor producing the male hormone had become augmented. Steinach discovered that after the operation the sperm-forming cells atrophy, but that the interstitial cells proliferate.

The book contains a review of the history and literature of the subject, but most readers will probably be interested chiefly in the details of the clinical cases, which are carefully recorded and are certainly remarkable. For example, a man prematurely old and incapable of doing his ordinary work in life is enabled by this very simple operation of vasoligation to become again a useful member of the community. It is a mistake to press unduly the recovery of sexual potency, which alone would not appear to some to justify even a slight operation. Amongst Eastern peoples an opposite opinion would probably be expressed. The fact remains that in carefully selected cases the whole body receives an impetus to what has not been inaptly described as rejuvenation. The same results have occurred in man after operation as Steinach previously noted as happening in decrepit old rats. And surely this need not be a cause of wonder if we remember the marvellous functions of the other endocrine glands, such as the thyroid, the suprarenals, and the pancreas, the knowledge of which has been gradually unfolded to our mental vision since the time of Brown-Séquard.

Many will read this book and gain a new interest in the experimental or Hunterian method of research.

L' Ostéosynthèse dans le Mal de Pott. By JAMES GEORGE KOPP., Royal 8vo. Pp. 184, with 12 illustrations. 1924. Amsterdam: N. V. Drukkerij.

THIS monograph on the treatment of Pott's disease of the spine consists of a general description of the disease, its anatomy, pathology, symptoms, and treatment; but in particular there is a detailed account of 58 cases in which operative treatment was employed with a view to bringing about spinal fusion. The majority of these cases were operated on by Professor Noordenbos. In the earlier cases Albee's method was used, but in the great majority Halstead's operation was performed. This consists in cutting the spinous processes away from the laminae, leaving them attached to the muscles on one side, and placing a tibial graft between the laminae and severed spinous processes. All the operations were done under local anaesthesia ($\frac{1}{2}$ per cent novocain). In 12 cases out of the 58 death followed at an interval varying between seven months and six years. In all cases it is claimed that a rapid recovery with sound fusion of the spine was the immediate result of the operation. No extravagant claims are made as to the influence of the graft on the cure of abscess or paraplegia.

Practically no attempt is made at mechanical fixation of the spine by any external apparatus. Possibly this is the explanation of the fact that there have been several cases of fracture of the graft.

The monograph affords a useful and fairly written account of a considerable series of cases treated by one surgeon.

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EPONYMS.

By SIR D'ARCY POWER, K.B.E., LONDON.

XVI. WHITEHEAD'S OPERATIONS.

WALTER WHITEHEAD, of Manchester, has given his name to two surgical operations, the one for the removal of the tongue, the other for the cure of piles.

Before the year 1877, and indeed for some time afterwards, it was the practice of surgeons to amputate the tongue by a rope or wire écraseur or by the galvano-cautery, with or without previous ligature of the lingual arteries. Anæsthesia at the time had not been reduced to a science. There were no clip forceps to arrest bleeding, the bruised stump of the tongue usually sloughed, and secondary hæmorrhage was frequent. It is no matter of wonder, therefore, that the mortality after operation was estimated at 30 to 60 per cent. Patients postponed the operation until the pain and ulceration became unbearable, and as little attention was directed to the removal of the infected glands, it is probable that few survived long after the surgeon's visit.

Mr. Walter Whitehead, who was then the Senior Assistant Surgeon to the Manchester Royal Infirmary, wrote: * "The following patient was a woman, aged 64, who had been suffering for about two months from an epithelial cancer, which had commenced on the right half of the tongue, and subsequently invaded the septum, and was admitted under my care at the Royal Infirmary, Manchester. Under the influence of chloroform, the tongue was drawn well forwards and upwards by means of a cord passed through the tip. I then took a strong pair of ordinary scissors and freely separated the tongue from its attachments to the gums in front and at each side, and then the muscles were deliberately snipped from before backwards at a plane well below the substance of the tongue. I adopted the plan of snipping from one side to the other in order, if possible, not to divide two arteries at one time; a plan which succeeded admirably, as the right ranine was cut and secured

* *British Medical Journal*, 1877, ii, p. 803.

before the left was wounded. When the left ranine artery was severed, the bleeding ceased before there was time to secure it. The remainder of the snipping was concluded, and the tongue removed well behind the foramen cæcum. There was no hæmorrhage, and the patient was removed to bed, not having lost more than an ounce of blood during the operation. Hæmorrhage, however, took place within the hour; and Mr. Richmond, the house-surgeon, had to make use of the thermo-cautery for its control; a lesson which would induce me on another occasion to make secure all the vessels before concluding the operation. The patient has since progressed most favourably. Her temperature has remained normal; and she expresses herself, in a voice distinctly audible, as feeling very well and very comfortable.

"The advantages I would claim for the operation are: (1) Extreme simplicity; (2) The prospect of quick convalescence; (3) The control obtained by scissors in the direction of the cut and the amount removed; (4) The absence of any sloughing, affording immunity from septic danger and lessening the risk of secondary hæmorrhage."

Mr. Whitehead discovered later that the method he was advocating had already been adopted by Billroth, who was still tying the lingual arteries before he cut away the tongue. Fuller details were given by Mr. Whitehead in a paper which he read at the Meeting of the International Medical Congress in London in 1881.* The paper is still of interest, because it shows how far surgeons have travelled in connection with the diagnosis, prognosis, and treatment of cancer of the tongue since the year 1881. The point upon which he laid most stress for the successful performance of the operation was that each snip with the scissors must be short, and alternately from one side to the other, in order to avoid the simultaneous division of the two ranine arteries. He used a heavy blunt-pointed scissors, the blades being half the length of the handles, and with his usual generosity he presented many pairs to hospital surgeons who adopted his operation, and they may still be found in the instrument cabinets of hospitals. He used also to apply 'Whitehead's varnish' to the stump of the tongue—a saturated solution of iodoform in ether with which the solid ingredients of friars' balsam had been incorporated.

The surgical treatment of hæmorrhoids, as it was practised by Whitehead, was explained in an article contributed to the *British Medical Journal* in February, 1882.† "The intention of the operation", he says, "is to remove from the lower segment of the rectum the diseased, dilated, and tortuous vessels and the adjacent tissues, hypertrophied and consolidated by plastic effusion. These diseased structures are situated beneath the mucous membrane of the rectum, and rest upon the circular fibres of the internal sphincter; and it is the object of the operation to clear them away from the anal orifice, where they act as obstructions to defæcation, and excitants of periodic and distressing spasmodic muscular contractions. During the past five years I have excised hæmorrhoidal tumours on a plan which I venture to believe to be more in harmony with the principles of modern surgery than the

* *Transactions of the International Medical Congress*, Vol. II, pp. 461-70.

† *British Medical Journal*, 1882, i, pp. 148-150.

operations in more general use, and I have abandoned those pyrotechnic aids and cumbersome appliances which at one time I regarded, I must confess, as indispensable. The operation is conducted under chloroform with the patient in the lithotomy position. As a preliminary measure, the functions of the sphincter are suspended by forcible dilatation. Two thumbs are introduced into the rectum and the circumference steadily kneaded until all resistance is overcome and the sphincter rendered absolutely passive. The patulous condition of the rectum thus obtained enables the whole mass of piles to be



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WALTER WHITEHEAD.

protruded through the anus. The hæmorrhoids in size and appearance resemble an average ripe tomato, and are mapped on the surface into four irregular and unequal lobes.

"The lobes are next divided into four segments by longitudinal sections in the axis of the bowel and in the furrows marking the intervals between the several lobes. This can be accomplished without the loss of any blood. Each portion is then secured in succession by ring-forceps and dissected with scissors, first, transversely from the anal margin, and then the dissection is

continued upwards in the cellular plane to the highest limit of the hæmorrhoidal growths. Each segment is then converted into a quadrilateral wedge-shaped mass, the base below consisting of the hæmorrhoids, and the apex above of the healthy mucous membrane of the bowel. The mucous membrane at the highest point is next transversely divided, leaving the hæmorrhoids attached by loose cellular tissue and the vessels proceeding from above and supplying the mass below. The forceps containing the hæmorrhoids are then twisted until a connection is severed and the hæmorrhoids are removed. The divided surface of mucous membrane is next drawn down and attached by several fine silk sutures to the denuded border at the verge of the anus. The sections throughout are made with scissors, and each mass of piles is treated in a similar manner until all are removed.

"The operation is based in the first place upon the anatomical foundation that the arteries in the lower part of the rectum descend from above, running vertically in parallel lines towards the end of the gut in the cellular tissue between the mucous membrane and the muscles. It is from this arrangement of the vessels that the surgeon is enabled to leave the torsion of the arteries to such a late stage of the operation.

"The dominant influence of the sphincter as a factor in the causation of hæmorrhoids is found equally potent as an agent during the after-treatment; and unless its influence is totally compromised by forcible distention secondary hæmorrhage may be concealed within the rectum. With the sphincter dilated, however, secondary hæmorrhage ceases to be a consideration of importance, and if during the operation collateral arteries be divided and bleed freely they can be treated on ordinary principles and twisted without difficulty.

"In the healthy rectum the mucous membrane is loosely connected with the adjacent muscle and readily detached, but in this operation it is one of the objects, and a main feature in the cure, to obtain adhesion between the mucous membrane and the muscular coat of the bowel in order to counteract for the future the tendency to hæmorrhoidal stasis by giving a substantial support to the vessels, and this is gained by uniting the healthy mucous membrane from above to the verge of the anus—an advantage which cannot be overestimated. It closes what would otherwise be an open wound in one of the most undesirable localities of the body, and by protecting the raw surface from the irritating influences of passing fæces prevents a considerable amount of after-suffering and admits the only possible chance of immediate repair.

"A contingency that will at once suggest itself to the minds of those who read this description is the risk of stricture likely to follow the cicatrix resulting from this plan of operation. I may mention that wherever it is feasible, with strict regard to removing every evidence of any hæmorrhoidal growth, I invariably leave longitudinal strips of mucous membrane continuous with the skin, but in severe cases requiring the removal of the entire circumference I have no fear of the bowel being inconveniently contracted when mucous membrane alone is sacrificed; and believe that undue contractions only take place when an annular cicatrix is formed at the expense of integument. I have taken great pains to ascertain that this fear is groundless, and

I have watched most of my cases for a sufficient length of time to relieve my mind of any farther anxiety on this point : at the same time I fully realize that the progress of such contraction is slow."

Walter Whitehead was born in 1810 at Haslam Hey, Bury, in Lancashire, where his ancestors had carried on an extensive business as bleachers for more than two hundred years. He was the direct descendant of John Kay, the inventor of the fly-shuttle which revolutionized the textile trade, and he was a cousin of Robert Whitehead, the inventor of the fish-torpedo which bears his name.

Whitehead showed a marked independence of character from childhood. At the age of 8 and "by the unanimous vote of all his relatives" he was sent to an academy in the Isle of Man, the head-master promising his father that he would see a marked improvement in his son within twelve months. He remained three years, and is reported to have changed "his dorsal integuments" several times without much alteration in his mental outlook. He afterwards attended a school at Altrincham, from which he ran away, and was educated finally at Making Place near Halifax, where under a competent head-master he quickly became head of the school. He entered his father's business at the age of 16, and remained for three years, until it was discovered that he had borrowed money to pay for lectures at the Chatham Street School of Medicine. He was apprenticed, therefore, to Drs. Harris and Bennett, who were in general practice in Bury, and in 1864 he qualified by taking the L.S.A. in London and the L.F.P.S. at Glasgow. He then settled in general practice at Mansfield in Nottinghamshire, where he organized what is now the Mansfield and District Hospital with accommodation for 104 patients, though it was opened in 1867 with eight beds. He returned to Manchester in 1868, having previously gained the F.R.C.S.Ed., and was elected Surgeon to St. Mary's Hospital for Women and Children, a post he resigned in 1873 on receiving the appointment of Assistant Surgeon to the Manchester Royal Infirmary. Here he became Surgeon in 1879, and resigned on reaching the age limit of 60 in 1900. He lectured on Clinical Surgery at the Owen's College School of Medicine from 1884 until he became Professor of Clinical Surgery in the Victoria University in 1892. In 1902 he was President of the British Medical Association, and as a memento of the occasion he issued a charmingly illustrated volume entitled *Some Apostles of Physiology*, written by Dr. William Stirling, the Brackenbury Professor of Physiology and Histology. Two hundred and fifty copies only were printed, and the name of the recipient was introduced into each. Whitehead was an enthusiastic yachtsman for many years, but in later life he lived retired but pleasantly employed in making gardens and shrubberies on a hillside at Colwyn Bay. Here he died after a long illness on August 19, 1913, having been twice married, and leaving one daughter.

The portrait is taken by permission from a photograph by Messrs. Elliott and Fry.

SOME CLINICAL ASPECTS OF CARCINOMA OF THE BREAST.

By RAYMOND JOHNSON, LONDON.

(Being the Bradshaw Lecture delivered at the Royal College of Surgeons of England on Nov. 6, 1924.)

EVERY aspect of this subject is provided with such a voluminous literature that it seems something like presumption on my part to venture to talk about it in this place. My object is to use the occasion to deal with my own clinical experience on certain special points rather than with the work of others in this field. The great value of the work done in connection with the diseases of the breast in this country and elsewhere, especially from the side of morbid anatomy, cannot be doubted; but on the other hand it is necessary to study without bias purely clinical evidence and endeavour to correlate this and the pathological evidence.

The first point which may be considered is the clinical evidence of definite pre-existing disease in a breast in which a carcinoma subsequently develops. The general impression would be that in the vast majority of cases a cancer of the breast reveals itself by the patient's accidental discovery of a lump in a gland in which there had never been any evidence of previous mischief. Is this general impression based upon satisfactory clinical evidence? In order to try to answer this question I have abstracted all the instances occurring among 444 personally observed cases of carcinoma in which there was clinical evidence of previous trouble in the gland, with the following result:—

EVIDENCE OF PREVIOUS DISEASE IN 444 CASES OF CARCINOMA OF THE BREAST.

	Cases
Lactation abscess	14
'Inflammation'	1
'Simple tumour' removed ..	4
'Simple tumour' diagnosed ..	4
Cyst removed	1
Chronic mastitis—operation for ..	1
Discharge from nipple	10

In the 14 cases of lactation abscess the interval between its occurrence and the discovery of the carcinoma varied between eighteen months and forty years, and in 11 of these the position of the two in the breast suggested only an accidental connection. In 2, however, the carcinoma developed close to the scar of the abscess, and in the remaining case a sinus was said to have persisted since the abscess more than thirty years previously. Thickening gradually occurred around the sinus, and at the age of 75 there was a typical ulcerated carcinoma. Operation was not performed, partly on account of

the patient's mental condition. She became insane and died two years later.

In the 4 cases in which a 'simple tumour' had been previously removed, the long interval—27, 23, 15, and 26 years respectively—rendered the suggestion that the original tumour was malignant practically impossible. It is of interest that in 3 instances the carcinoma developed beneath the scar; in the fourth case, however, the position did not correspond.

Of the other 4 cases in which a 'simple tumour' had been previously diagnosed in the position of the later carcinoma, in one of sixteen years' duration the tumour was regarded as a 'chronic mammary tumour', and in another of seventeen years' duration 'adenoma' had been diagnosed. In the 2 remaining cases a lump had been known to exist for fourteen and twenty-six years respectively. I have no explanation to offer of these cases, and unfortunately have no information as to the actual nature of those tumours which were removed. Possibly they were cystic. One can only hazard the suggestion that in those cases in which a carcinoma developed beneath the scar, many years after an operation for abscess or 'simple tumour', it may have been some condition set up in the breast at the site of the operation, rather than the nature of the condition for which the operation had been performed, which determined the later development of the malignant growth. The not infrequent development of squamous carcinoma in connection with a scar in the skin is well known; but I am not aware of any evidence showing that carcinoma of a glandular organ, such as the breast, may also arise in a similar manner. It certainly appears to be more than a coincidence that, among 18 cases of carcinoma developing in a breast in which an operation for some other condition had been performed many years previously, in 6 the growth should have developed immediately beneath the scar in the skin. A tempting explanation of the small group in which a lump had existed for many years before it assumed the characters of malignancy would be that a fibro-adenoma had become a carcinoma. Personally I know of only one specimen suggesting that such a change had occurred. Clinical evidence on this point, in view of the many mistakes in the diagnosis of fibro-adenoma, is altogether untrustworthy. It seems, indeed, extremely rare for a benign growth to alter its type and become malignant. The two examples which always seem to me the most suggestive are the change of an endothelioma into an endothelial sarcoma, and of a neurofibroma into a sarcoma—the 'secondary malignant neuroma' of Garré.

CYSTIC DISEASE AND CARCINOMA.

Of the remaining three conditions—cystic disease, chronic mastitis, and discharge from the nipple—more must be said. The consideration of the very important question of the relation between cystic disease of the breast and carcinoma may be approached in two ways, the clinical and the pathological. The clinical method will chiefly consist in the search for cases in which a breast, at one time the seat of cystic disease, develops carcinoma later. The pathological method concerns itself with the study of the evidence that a given specimen of carcinoma has originated in pre-existing cystic disease

and the detection of unsuspected carcinoma in a cystic breast. In studying the matter from the clinical side, I have limited myself to the clinically isolated cyst (not necessarily single), as opposed to those cases in which more or less widely-spread cystic disease involves one or both breasts, and in which complete removal is the only available treatment. There is no doubt that Sir G. Lenthal Cheate is quite correct in his statement that there is no such thing as a single mammary cyst; but it is not less true that a cyst often occurs clinically as an isolated tumour without evidence of the smaller cysts which are no doubt present. Incidentally, there can, I think, be no question that a small tense cyst deep in the substance of the breast may more closely simulate carcinoma than any other condition, so that often the only basis for a correct diagnosis is the detection of a sense of elasticity by the trained fingers. My own position in relation to the detection of elasticity is divided into two periods—the earlier, when I missed it and thus mistook a cyst for a carcinoma, and the later period, when I felt elasticity which was not present and thus mistook a carcinoma for a cyst!

My own practice when dealing with an isolated cyst of the breast—and the same treatment has been adopted when two or even three tumours were present—has been to excise the cyst with a narrow zone of the surrounding breast tissue. I think I have only twice tapped a mammary cyst, although there would be a third case if the tense cyst had not ruptured when grasped with the fingers of the left hand. It is not only safer to remove the cyst as being the one means of being quite sure of its real nature, but tapping is a very uncertain method, even though the cyst is injected at the same time. The question which interests me is whether, if I were beginning practice again, I should adopt the same treatment, or whether the whole breast should be removed for fear of the later development of carcinoma. The development of another cyst in the same breast may necessitate a second or even third operation; but this hardly in itself seems to justify complete removal in the first instance.

To assist in answering the question before us, I have investigated my own series of 107 cases of cyst of the breast and have noted, as far as was known, the course of each. In 39 cases the lump caused by the cyst was only known to have existed for periods varying from a few days to a few months before the patient came under observation, and later news was not obtained. In 3 cases the whole breast was removed in the first instance, an erroneous diagnosis of carcinoma having been made. These 42 cases are thus of no value in elucidating the question. In 34 instances after the local removal of a cyst the patient was known to be free from further trouble for periods varying from one to nineteen years. In one case no fresh development had occurred fifteen years after a cyst had been tapped and injected with carbolic acid. In 3 cases more than one operation was performed for cysts in the same breast: in one case four operations in four years, in another two operations in four years, and in the third two operations in three and a half years. In 14 cases cysts were dealt with at different times in both breasts, the periods during which the patients were under observation varying from one to eighteen and a half years. In 3 cases, although the patients were not seen again after operation, there was evidence that the tumour caused by

the cyst had existed for eight years, one year, and three years respectively. In 4 cases in which after operation another cyst developed in the same breast, but was not treated, the interval varied from two and a half to twenty years; and in 2 cases in which a tumour having all the characters of a cyst was present in both breasts, but no operation was performed, the tumours in one case had existed for three years, and in the other the patient was under observation for sixteen years. Thus in 61 cases the patient was under observation for periods varying from one to twenty years without any evidence of the development of carcinoma.

There now remain 4 cases in which a cyst and a carcinoma were both dealt with. In 2 of these the cystic disease was in the opposite breast to the carcinoma. In the first the left breast was removed for a central spheroidal-celled carcinoma, and at the same time two simple cysts were removed from the right breast. In the second case the right breast was removed for a typical spheroidal-celled carcinoma of eighteen months' duration, and a year later a cyst, recently noticed and as large as a pigeon's egg, was removed from the left breast, there being no evidence of recurrence of the carcinoma. There is, of course, no proof that in these two cases the connection between the two affections was more than accidental.

In the 2 remaining cases the cystic disease and the carcinoma both occurred in the same breast. In the first of these a cyst of the left breast was removed by another surgeon, when the patient was 33 years of age; the cyst was examined microscopically and pronounced to be simple. Some discomfort was subsequently experienced, and ten and a half years later I saw the patient for enlarged glands in the left axilla which had been noticed for three weeks. There was induration beneath the scar of the previous operation, and complete removal was carried out. The tumour was a richly cellular carcinoma, tending to an acinous arrangement, and there were secondary deposits in the glands. Death occurred nineteen months later, with thoracic symptoms of only a few weeks' duration. This is the only case in which I have operated for carcinoma in a patient in whom an operation for cyst had previously been performed on the same breast, and the long interval which elapsed compels me to doubt whether the connection between the cyst and the carcinoma was in any respect more intimate than in the cases before mentioned in which a carcinoma developed beneath the scar resulting from an operation for lactation abscess or 'simple tumour' many years previously.

In the second case I saw the patient for a tumour of the right breast of about nine months' duration. There was an almost central elastic tumour as large as a Tangerine orange; the nipple was retracted, and the glands, although palpable, were not larger than on the left side. A simple cyst was diagnosed, and removed locally. The cyst was not of the characteristic 'blue-domed' variety, and contained a dirty creamy fluid, so that I was a little doubtful of its entirely simple nature. Microscopic examination, however, showed no evidence of new growth. Four years later I heard that another surgeon had removed the breast and that the microscope revealed the presence of a 'duct carcinoma'. Death occurred two years later, with signs of malignant disease of the liver and the presence of an enlarged gland above the clavicle.

To sum up my own clinical experience in this matter—among 107 cases of cyst and 444 cases of carcinoma I know of only 2—and one of these not a very straightforward one—in which a carcinoma subsequently developed in a breast from which a cyst had been previously removed. This evidence would therefore lead me to the conclusion that the connection between cyst and carcinoma is a remote one, and justifies the treatment of a simple cyst by local removal.

In approaching this same subject from the pathological aspect, I feel considerable hesitation in even mentioning my own experience in view of the extensive and well-known investigations of Lenthal Cheatele on this subject. Reference must be made, however, to a few cases bearing on the question, and especially to four cases in which a carcinoma was found in association with a definite cyst. In one the only suspicious clinical feature was the presence of a very slight dimple in the skin over the cyst; examination after local removal showed an appearance of new growth at one spot, and the complete operation was performed. In the second case a typical spheroidal-celled carcinoma was found in the wall of a cyst as large as a small plum; the rest of the breast was indurated and contained many minute cysts. In the third case the tumour was clearly cystic but surrounded by indurated tissue, which after local removal was thought to be due to chronic mastitis. Examination showed, however, the typical structure of spheroidal-celled carcinoma, and the complete operation was performed. In the fourth case an apparently simple cyst was removed by the patient's doctor; spheroidal-celled carcinoma was demonstrated, and I performed the complete operation.

I may also refer to another case, in which, however, there was no opportunity of making a pathological examination. The patient was 82, and had been conscious of a lump in the upper and outer part of the right breast for thirty years, and for a short time had noticed a lump in the axilla. A large acute axillary abscess developed and was opened, but it was not possible to decide whether or not it was entirely inflammatory. The tumour in the breast was apparently cystic. The patient died two years later with, according to the account of the son, who was a medical man, unmistakable carcinoma. In this case it seems reasonable to suppose that an old-standing cystic affection later became malignant.

Four such specimens as those described are at least significant, and it is difficult to avoid the conclusion that if the cyst had not been present the carcinoma would not have arisen. They point rather strongly in a direction opposite to that indicated by my own clinical experience.

Cheatele,¹ in a recent lecture, has referred to the investigations of Bloodgood, of Baltimore, which were undertaken to show that cysts of the breast are dangerous, but led him to the conclusion that large 'blue-domed' cysts are not dangerous. Cheatele expresses his agreement that "as a rule this kind of cyst is not very dangerous," but mentions three of his own specimens in which carcinoma began in one. It is the smaller developing cysts which he regards as more dangerous, and in them papilloma and carcinoma may develop either together or separately in the same breast. From his experience he maintains that even breasts containing big cysts ought to be removed.

The position seems to me very perplexing, for I have been in the habit

of removing just that part—the big cyst—which Cheatele regards as the least dangerous, and leaving most of the rest of the breast with its small cysts, etc., which he considers the most dangerous. Guided by my own clinical experience alone, I should not know whether to remove the breast containing the cyst or the opposite one, for, as we have already seen, in two cases the carcinoma developed in the same breast and in two in the opposite one.

My final decision would be to continue to remove locally a cyst which is clinically isolated, but if the surrounding tissue is found to be extensively cystic, to remove the whole breast. The tissue around the cyst should in all cases be examined microscopically, and of course if carcinoma is found, the complete operation should be performed.

CHRONIC MASTITIS AND CARCINOMA.

A further reference to the statistics on p. 630 shows that in only one case had an operation been performed previously for chronic mastitis, and in no other case had this condition been diagnosed and carcinoma subsequently developed. The case in question was that of a single woman, age 58, who was first seen with an ill-defined induration in the upper and outer quadrant of the left breast, stated to be of ten years' duration. The diagnosis was somewhat uncertain, and the indurated part was excised locally and proved at an immediate microscopic examination to present no evidence of growth. Four and a half years later the patient was seen again, with a lump beneath the scar and retraction of the nipple, both only recently noticed. The complete operation was performed, and microscopic examination confirmed the diagnosis of carcinoma. A report nine and a half years later stated that the patient was well, but that there was "some thickening of the scar".

As a digression, I may state my entire agreement with those who hold that local recurrences in the actual scar are rare. I have more than once removed a rather suspicious thickening of the scar of the incision or a stitch puncture, only to find a fibrous hyperplasia. In one instance a nodule in the scar proved to be an implantation dermoid, and it is perhaps strange that such dermoids are not more common in the scars of operation wounds. As an exception to the rule above stated, a case may be mentioned in which the only local recurrence occurred in the scar of the puncture for the drainage tube.

In using the term 'chronic mastitis' I realize that I am on dangerous ground, and have no desire in doing so to set myself up in opposition to Sir G. Lenthal Cheatele, who regards the term as erroneous and considers the condition to be characterized essentially by 'hyperplasia of the breast tissue'. Cheatele (*loc. cit.*), in one of his most recent communications, has pointed out certain clinical features which, in his opinion, may serve to indicate the presence of those forms of epithelial hyperplasia which he regards as dangerous. In my ignorance of these signs I have been compelled to group together a number of cases under the perhaps inaccurate term 'chronic mastitis'. The conditions are variable, and include localized indurations, single or multiple, usually ill-defined in outline and leathery in consistence; localized indurations more nodular in character, the result of small cystic formations not large enough to give the signs of fluid; and lastly, more diffuse conditions,

affecting one or both breasts, and presenting characters corresponding with those of the localized forms.

It will thus appear that no sharp line can be drawn between the clinically single simple cyst and a local or more diffuse induration in which there is no clinical evidence of cyst formation.

My own cases coming under this heading number only 77. In 47 no operation was performed; in 20 the affected part of the breast was removed locally; in 8 the whole breast was removed, and in 1 the complete operation was performed, because, after excising the local induration, it was thought to be malignant. It is to be regretted that my records of the later history of the 67 cases in which either no operation was performed or the indurated part was removed locally are not sufficiently full to be of practical value. Reference has already been made to the one case in which a carcinoma developed subsequently to the local removal of a microscopically simple induration; but I am impressed by the fact that of the 47 cases in which no operation was performed none was subsequently seen for carcinoma.

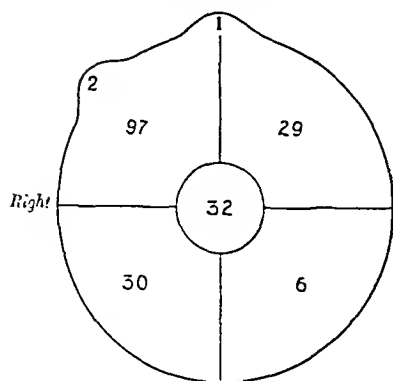
And here I would venture, although with considerable hesitation, to express my belief that there is a tendency to remove the breast, or even both breasts, for comparatively slight and ill-defined indurations more readily than the evidence of their importance seems to call for.

As possibly throwing some light on the question of a relationship between carcinoma, cyst, and chronic mastitis, a diagram (*Fig. 377*) has been prepared showing the parts of the breast affected by each, using for the purpose only those cases in which the position was accurately stated. The result is interesting, and shows that not only is carcinoma most common in the upper and outer quadrant, but that cysts and chronic mastitis are also more common in the same quadrant. Indeed, of a total of 560 lumps in the breast due to one or another of these three conditions, 265, or nearly one-half, occurred in the upper and outer quadrant. This may fairly be used as a piece of evidence pointing to some relation between the three conditions, but why the upper and outer quadrant should be so much more liable than other parts of the breast is a mystery to me. Is it because this part of the breast is more exposed to injury, or has it any conceivable relation with the course of the lymphatic drainage?

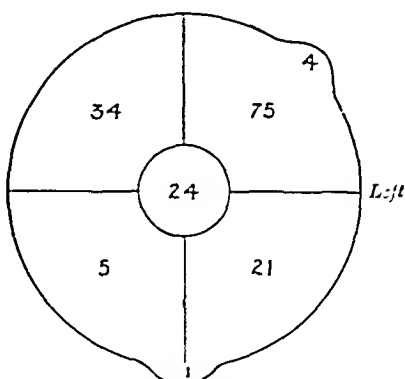
Although a digression, I should like to refer to a small matter of clinical interest, which at first sight seems hardly to have any connection with the subject before us. I refer to the condition in which a prominent and tender rib cartilage is present and is mistaken by the patient, and possibly the surgeon, for an affection of the breast. I first learned of this condition, as of many others of anatomico-surgical interest, from Sir Rickman Godlee, and I quote his remarks on the subject from his work with Sir James Kingston Fowler on *The Diseases of the Lungs* :—

“Bifurcation of the anterior extremity of a rib or the corresponding cartilage is occasionally met with; or there may be an additional cartilage projecting from the side of the sternum. These anomalies are mostly unilateral, and the additional cartilage is almost always in the third interspace. Extremely prominent ribs or rib cartilages are not infrequently met with, and, as far as I have seen, mostly in the same situation; these may give rise

FIG. 377.—DIAGRAM SHOWING THE POSITION IN THE BREAST OF
CARCINOMA, CYST, AND CHRONIC MASTITIS.

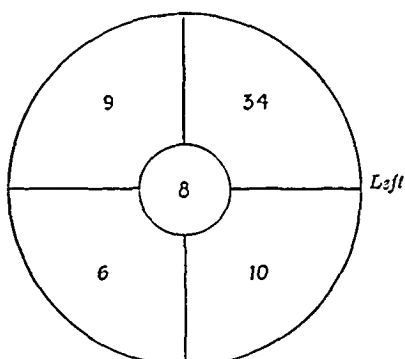
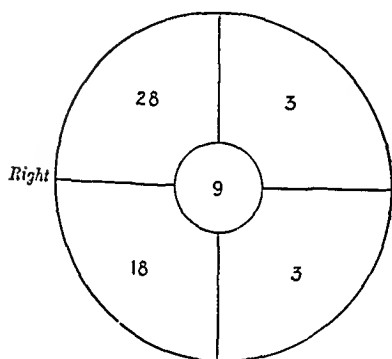


DIFFUSE 11

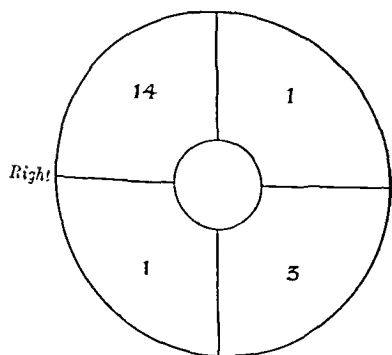


DIFFUSE 12

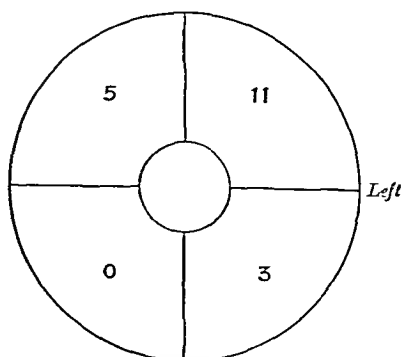
Carcinoma: *Right* 208, *Left* 177: Total 385.



Cyst: *Right* 61, *Left*, 67: Total 128.



DIFFUSE 3



DIFFUSE 6

Chronic Mastitis: *Right* 22, *Left* 25: Total 47.

to a suspicion of tumour, and therefore claim a brief notice in this work. I have notes of at least three cases of young women to whom considerable mental anxiety and, apparently, a good deal of pain, were caused by this anatomical peculiarity."

Sir Rickman has pointed out to me that the rib cartilages even in health are always more or less tender on pressure, so that it is easy to understand how a young woman who has perhaps lost flesh discovers a prominent tender lump and at once concludes that she has cancer. I have seen at least two cases of this kind, and in one of them supposed that the symptoms were due to some chronic mastitis affecting the upper and inner quadrant of the breast. I removed the apparently affected part; but the breast tissue seemed quite normal, and I have no doubt that the prominent third rib cartilage which lay beneath it was the sole cause of the pain and tenderness.

DISCHARGE FROM THE NIPPLE.

Referring yet once more to the analysis of cases on p. 630, it will be seen that in 10 cases of carcinoma there was a history of discharge from the nipple, which had been noticed for variable periods before the discovery of the tumour. This physical sign of disease of the breast is in my experience not common; nevertheless it is of considerable interest and practical importance, and, though they are few, I have ventured to note the main points in my own cases, dividing them according to the character of the discharge—blood-stained and colourless. Among the 20 cases in which the discharge was blood-stained are 4 in which, when the patient was first seen, there were no other physical signs. In three nothing was done; in one of these the patient had "forgotten all about it" five years later; one was not seen again; in the third case operation was performed three years later for Paget's disease and carcinoma. In the fourth case operation was advised, and the breast, which was removed elsewhere, was the seat of a cystic mastitis, in which were cysts containing papillomas. In 4 cases an intracystic papilloma was present. In 2 there was cystic mastitis. In 10 cases a tumour was present, diagnosed as carcinoma and confirmed by operation in 9. In one case a very large tumour was diagnosed as either sarcoma or cystic adenoma, but was not submitted to operation. It is interesting to note that among the 9 carcinomas were 2 in which a small cyst containing a papilloma was present in connection with the growth; 2 in which the cells, although spheroidal, had a papillomatous arrangement; one was columnar-celled; and in one the breast tissue was cystic. One almost feels justified in stating that, when a blood-stained discharge occurs in a case of ordinary carcinoma, it is an associated intracystic papilloma, and not the tumour itself, which bleeds.

From the clinical standpoint a blood-stained discharge from the nipple may be met with in three circumstances: (1) It may occur in association with other signs of disease of the breast, which determine the method of treatment. (2) It may be unattended with other physical signs, but it can be shown that pressure on a particular spot induces the discharge; in such a case this part of the breast should be removed locally, and, unless obviously malignant, submitted to careful microscopic examination before

deciding whether complete removal is necessary. (3) The discharge may not only be unattended with other physical signs, but the part of the breast in which it arises cannot be demonstrated: in such a case the whole breast should in my opinion be removed. Several of my cases support this opinion, that which most strongly impressed me being the one in which, three years after I first saw the patient, Paget's disease and carcinoma had developed.

Among the 18 cases of colourless discharge were 2 in which no physical signs were present and nothing was done: in one of these the discharge was known to have ceased three and a half years later. In 7 cases various forms of cystic disease were present. In 8 cases a carcinoma was present, and in one a tumour regarded as a perithelioma. Of the 8 carcinomas, 6 were of the ordinary type, 4 being central and one present in a cystic breast; one was associated with Paget's disease, and one was columnar-celled.

If a colourless discharge is considered in the same three clinical groups as the blood-stained, I should suggest that the same line of treatment is adopted, except that in the third group very little risk will probably be run if no operative measures are undertaken.

INJURY AND CARCINOMA.

In considering the clinical evidences of pre-existent conditions in the breast favouring the development of carcinoma, mention must be made of the possible influence of previous injury. Sampson Handley, in his work on *Cancer of the Breast*, carefully considers this question, and records what he believes to be the first case in which the doctrine of traumatic carcinoma was accepted in the English High Courts. He also quotes numerous significant cases from W. B. Coley's well-known article "On Injury as a Causative Factor in Cancer". Handley concludes that in order to establish a case of traumatic carcinoma it must be shown that the injury was a single one of some severity, causing recognizable objective signs such as bruising, that no lump was present in the breast previously, that the injury preceded the tumour by not longer than a year, that the tumour appeared at the exact site of injury, and that its nature was established by microscopic examination.

The necessity of the last condition is obvious, and in this connection attention should be drawn to a very interesting affection described by Lee and Adair,² Stulz and Fontaine,³ and others under the names of 'traumatic fat necrosis of the female breast' and 'granulome lipophagique'. In one of Lee and Adair's cases, a very fat woman, age 52, received a violent blow on the right breast. Three months later a hard tumour above the nipple was diagnosed as a carcinoma, and operation performed accordingly. A yellowish-brown tumour was present, which on examination showed broad zones of fat necrosis and very active proliferation of connective tissue. In one of Stulz and Fontaine's cases a woman of 53 fell while pushing a small cart, one of the handles of which struck her violently on the left breast, and some days later an ecchymosis appeared at the seat of injury. After two months there was still slight staining over the upper and inner part of the breast, and a little lower there was a hard tumour, the skin over which presented the *peau d'orange* appearance. There was no glandular enlargement. Cancer was

diagnosed, and the breast with the axillary contents was removed by Sencert. A section of the breast showed a hard nodule containing a small cavity filled with oily liquid. The solid part was of a brownish tint, with numerous hæmorrhagic points, and the microscopic structure was similar to that found by Lee and Adair.

In three of Lee and Adair's cases a tumour of this nature had followed a subcutaneous injection given during an operation. Thus in one case a woman of 36 received an injection of physiological serum below the right breast during an operation for ruptured ectopic gestation. Six months later there was a hard tumour at the lower part of the breast which was regarded as carcinoma. A radical operation was performed, but examination showed that the supposed cancer was of the same nature as those under consideration. In one of the later cases, in which the tumour was seen ten months after an injection given during hysterectomy, the nature of the condition was suspected, the tumour alone removed, and its nature confirmed by microscopic examination. Stulz and Fontaine have collected in all nine cases of this type in the breast, and give references to similar conditions found in other situations. Of the 9 breast cases the condition occurred in 6 after a blow and in 3 after an injection. Obesity was noted in 6. In 6 cases the lump resembled carcinoma, and in 3 a simple tumour. A *peau d'orange* condition of the skin was present in all the 6 cases resembling cancer; palpable glands were present in only one.

I have thought it worth while to refer to this interesting series of cases, of which, however, I have no personal experience, because it may be well to bear them in mind in the case of a lump in the breast following a definite injury.

Among my own cases of carcinoma are a large number in which the patient assigned the disease to a previous injury, but none in which Handley's conditions were fulfilled for regarding the one as the result of the other; and in the four cases in which there was a clear history of bruising, the interval between the injury and the discovery of the tumour was a few weeks, twenty-one months, two years, and twelve years respectively. Coming back to the original question, my own experience leads to the conclusion that in most cases carcinoma of the breast is discovered accidentally in a gland in which there is no clinical evidence of any previous disease.

In the case of a doubtful lump in the breast the surgeon should lay the position clearly before the patient, and obtain consent to proceed at once to the complete operation if exploration proves this to be necessary. And here I would insist upon the importance of excising the doubtful tumour rather than merely incising it *in situ*. I was early impressed with the importance of this when assisting at an operation in such a case. An exploratory incision revealed only a dense, apparently solid mass, regarded as without doubt a carcinoma. After the complete operation had been performed, further examination showed that the exploratory incision had missed by a fraction of an inch a small chronic abscess. My further experience is that very rarely does a careful naked-eye examination fail to enable the surgeon to decide whether or not local removal is sufficient, and consequently that an immediate microscopic examination is very rarely called for.

Incidentally it may be mentioned that the preparation of a microscopic specimen during the operation is not a recently discovered aid in diagnosis, and was employed by Mareus Beek when I was his house surgeon nearly forty years ago, and is referred to by Beek in the ninth edition of *Erichsen's Surgery*, 1888, in the following words: "In all cases in which there is doubt as to the nature of the growth, an incision should be made into it if it is a case fit for removal by operation, and if necessary a slice should be removed, or a scraping of it, or a section cut after freezing may be put under the microscope". As a rule the difference between a small hard carcinoma and a patch of indurated breast tissue is almost as marked to the naked eye as under the microscope, whilst in really difficult cases, as for instance in the distinction between a duct papilloma and a papillary carcinoma, a leisurely and deliberate examination of a carefully prepared specimen is required. In such a case it is better to postpone the decision until this has been possible, even at the risk of exposing the patient to two operations.

It would be entirely out of place to consider here the general subject of the diagnosis of carcinoma of the breast, but mention may be made of one form in which a mistake is especially apt to occur, viz., carcinoma of unusually peripheral origin and beginning apparently in an outlying lobule on the surface or at the extreme periphery of the gland. In 4 cases of this nature a wrong diagnosis was made, 3 being regarded as fibro-adenomas and 1 as a cyst. In all the diagnosis was considered to be so certain that the tumour was removed under local anæsthesia before its true nature was discovered. In each instance the tumour was very small, movable on the surface of the breast, and unconnected with the skin.

Allied to cases of this kind are those very interesting ones in which the disease begins in the so-called 'axillary tail' of the breast, and in which the patient seeks advice for a tumour under the arm. Six cases of this kind have come under my notice, and in 4 of them a correct diagnosis was made, the tumour lying in the anterior part of the axilla under cover of the pectoralis major and at an early stage becoming adherent to the skin. In 2 cases, however, the connection of the tumour with the breast was not at first recognized, and it was regarded as glandular. In one of these cases this seemed so certain that the notes especially record the fact that no septic focus or new growth, melanotic or other, was found. The other case is particularly interesting. A poorly-nourished woman, age 26, who had been the subject of extreme scoliosis since early childhood, had noticed a lump in the left axilla for four months. There was a large hard mass under cover of the pectoral muscle just above its insertion, discharging a thin fluid through an ulcerated opening in the skin. A diagnosis of tuberculous glands was made, but operation revealed the nature of the case, and the complete operation was performed. The growth involved the extreme outer end of an unusually developed axillary lobe. Recurrence proved fatal in about eighteen months. It is interesting that the patient's mother had been operated on for cancer of the breast six months previously. Cases of this nature may be confused with those in which occasionally the axillary glandular tumour attracts the patient's notice while the small primary tumour in the breast itself is still unrecognized.

This leads to the general statement that it is exceedingly rare in the case of carcinoma of the breast for a secondary deposit to attract attention and be regarded as the primary disease whilst the really primary tumour in the breast is overlooked. This is perhaps not surprising when the readiness with which a tumour of the breast is usually detected is taken into account, and it is of interest that, at a discussion at the Royal Society of Medicine in 1919 on "Secondary Deposits in Bone mistaken for Primary Tumours", no case of the kind was mentioned in connection with carcinoma of the breast.

My personal experience of such an occurrence is limited to a single case published in 1892 in association with Dr. George Murray.⁴ The patient, age 44, under the care of Dr. Sydney Ringer, in University College Hospital, had suffered for six months from pain in the scapular regions, soon followed by wasting and loss of power in certain muscles of both upper limbs. The diagnosis was obscure until a small hard tumour, having the characters of a carcinoma, was accidentally discovered in the right breast. Death occurred on the seventeenth day with chest complications, and at the autopsy a mass of growth was found in the mediastinum, involving also the spinal column. The further interest of the case lay in the fact that it afforded a demonstration of the muscles supplied by certain nerve-roots. Thus, the sixth cervical roots were involved in the growth whilst the fifth roots were free, and correspondingly the sternal and costal fibres of the pectoralis major were atrophied whilst the clavicular fibres were unaffected.

A further elaboration of the same point is that it seems very rare to find evidences of metastases in a case of carcinoma of the breast in which the disease is still in an operable condition. Although in every case it is essential that a thorough general examination of the patient should be made, it is very exceptionally that any sign of a secondary deposit is found. My experience may be unusual, but in my own series I can find only one instance in which an operable carcinoma had already produced a recognizable metastasis which rendered operation useless. The patient, age 48, had noticed a lump in the right breast for thirteen months, and for eight months had suffered from pain in the back and 'sciatica'. The tumour was apparently very favourable for operation, and there were no palpable axillary glands, but there was complete flaccid paraplegia, and X-ray examination showed deposits in the dorsal spine and in one rib. A striking case of this kind has recently been recorded by Thompson and Keiller,⁵ of Galveston, the patient being a young woman, age 28. The most marked features were pain in the lumbar spine, spontaneous fracture of each humerus, and the detection of many skeletal deposits of growth by X-ray examination. A small lump in the left breast, said to have been present since the age of 10, was at first not regarded as connected with the other findings, and a diagnosis of multiple myelomas was made. Nine months after the onset of the symptoms the breast was removed and found to be the seat of carcinoma.

If the general examination is to be really thorough, it should, I suppose, include an X-ray examination of the chest and an examination of the pelvis. I must confess to having omitted almost systematically examination of the pelvis, although, looking to the frequency with which metastases occur in this situation, it seems to me that it is really as essential as the systematic

examination of the chest and abdomen. One of my latest cases impressed this very forcibly upon me. I removed the right breast of a woman, age 64, for a small spheroidal-celled carcinoma, the axillary glands showing no sign of disease. Only three and a half months later the patient was readmitted to hospital with signs of free fluid in the abdomen and a hard mass rising out of the pelvis on the left side. Pelvic examination showed a large tumour, probably involving the ovaries and peritoneum, which could doubtless have been detected before the breast was removed. The change of opinion concerning the explanation of these ovarian metastases in breast cancer is a fascinating study, and leads us from the earlier and purely fanciful sympathetic theory to the direct lymphatic permeation explanation of Handley. Sympathy has indeed ceased to be regarded as a potent factor in pathology!

This may seem an appropriate place to record four cases in which malignant disease of the breast occurred in women who, either previously or subsequently, were also the subjects of malignant disease of the uterus or ovary, the growth in each position being carcinomatous and apparently primary. The pelvic operation in each case was performed by my colleague, Dr. Herbert Spencer, in University College Hospital, and I am indebted to him for permission to use the information which he has given me.

Case 1.—Age 46. Malignant ovarian tumour (spheroidal-celled carcinoma), removed May, 1915. Right breast removed for central carcinoma (spheroidal-celled) of six months' duration, February, 1921; no palpable glands in right axilla, but several enlarged glands in left posterior triangle and in left lumbar region. In May, 1921, signs of recurrence in pelvis.

Case 2.—Age 68. Malignant papilloma of the ovary, removed March, 1920. Left breast removed for soft haemorrhagic tumour (very cellular spheroidal-celled carcinoma) of nine months' duration, April, 1920. No evidence of recurrence of either tumour in April, 1924.

Case 3.—Age 56. Abdominal hysterectomy for carcinoma of body of uterus (papillary), July, 1920. Right breast removed for carcinoma (spheroidal-celled), April, 1923. No evidence of recurrence of either tumour in August, 1924.

Case 4.—Age 47. Partial removal of the left breast for 'cancerous tumour' (structure not known), September, 1916. Vaginal hysterectomy for carcinoma of cervix (squamous-celled), November, 1916. Hard fixed masses in pelvis, probably glandular, and enlarged glands in left axilla in November, 1919.

In reviewing these four cases, it will be noticed that in *Cases 2 and 3* the difference in structure of the breast and pelvic tumours is sufficient proof that one was not secondary to the other. In *Case 1* the two tumours were sufficiently similar in structure to make it possible that one was secondary to the other. If the ovarian tumour was secondary to the breast, it must be assumed that it was removed by operation more than five years before the primary breast tumour was detected. Could, however, the ovarian carcinoma have been primary, and were the glands in the left posterior triangle of the neck and the tumour in the right breast secondary to it? Both views seem too improbable for acceptance, and the remaining view—that both tumours were primary—appears the most likely solution.

In the fourth case the nature of the breast tumour is unknown, but that it was malignant is practically certain in view of the axillary glandular

enlargement three years subsequently, and it must be regarded as practically certain that it, as well as the squamous-celled carcinoma of the cervix, was primary.

A consideration of these cases suggests two interesting questions. First, Has an unmistakably secondary carcinoma ever been seen in the breast, except from disease of the opposite gland? Secondly, Can the minute structure of a cancer in the breast be such as to prove that it could not have arisen in the gland itself? The answer to the first question is, I believe, in the negative. With regard to the second question, I should until recently have supposed that of the three ordinary forms of carcinoma—spheroidal, columnar, and squamous—the last could not be of primary breast origin. In 1918, however, I published with Mr. T. W. P. Lawrence⁶ “Two Cases of Squamous Epithelial Tumour of the Breast”. In one of these the tumour had almost certainly arisen in the skin, but in the other case the tumour was embedded in the breast substance and was entirely unconnected with the skin. The tumour was composed of irregular epithelial masses, the cells of which were in large measure very perfectly developed prickly-cells. Among the epithelial masses were numerous irregular gland-like spaces lined with spheroidal epithelium, and scattered through the tumour were small islands of breast tissue with fat. The only similar tumour of which we could find a record was one described by Konjetzny, who suggested that the tumour probably arose in an early embryonic ectodermal rest. Although it is doubtful if a tumour of this nature is really carcinomatous, it shows at any rate that the presence of a squamous-celled growth in the breast substance is not a proof that the tumour is secondary.

BILATERAL CARCINOMA.

The question under consideration is closely connected with that of carcinoma of both breasts and the relation of the disease in one breast to that in the other. I entirely agree with the opinion expressed by Stiles⁷ over thirty ago that “when both breasts become cancerous, one subsequently to the other, the disease in that affected later is, in the majority of cases, probably the result of lymphatic infection, and not a primary condition”.

Stiles is of opinion that the invasion of the second breast is by way of the retromammary lymphatics, and points out that by the same route the lymph glands in the axilla on the side opposite to that of the mammary tumour may occasionally be involved. As an example of this, he quotes a case of Chicne's in which the patient presented herself with a second recurrence in the left mammary region; there was a large mass in the left axilla and two masses were present in the right axilla, there being no evidence of disease in the right breast. I have seen a striking case of this kind, in which a small hard carcinoma, said to have been of three years' duration, and situated in the outer part of the *left* breast, was associated with extensive disease of the glands in the *right* axilla, there being no palpable glands in the left axilla, and the right breast appearing to be normal. No one would hesitate to regard the disease of the lymph glands in such a case as secondary, and after all it is a shorter lymphatic journey to the opposite breast than to the opposite axilla.

On the other hand, there is no difficulty in supposing that in some cases the disease arises primarily on both sides, and if this be the case the breasts would only be illustrating the occasional occurrence of bilateral malignant disease in paired organs.

In one of my cases the type of growth on the two sides was so different that it is difficult to suppose that one was secondary to the other. The tumour of the right breast was a small, hard, shrinking carcinoma; that in the left, removed six years later, was unlike any other which I have examined. It presented to the naked eye an appearance exactly like an angioma, appearing to consist of a fine spongy mesh-work full of blood. Microscopically it



FIG. 378.—Hæmorrhagic carcinoma.
All the spaces in the tumour are filled with blood.

had the structure of a very richly cellular spheroidal-celled carcinoma, the centre of the large cell masses being occupied by blood (*Fig. 378*). Apart from this difference in the structure of the two tumours, it seems probable in such a case as this, when a period of several years elapses between the first operation and the detection of the second tumour, and in the absence of any signs of recurrence of the first tumour, that both tumours are primary.

My own small series of 16 cases of bilateral disease are most disappointing, and call for little comment. Six were known to be dead; 4 were seen with signs of metastasis, and in 1 the operation was incomplete. Three were not seen after the second operation, and in only 2 was the patient

known to be apparently free from recurrence one and two years respectively after the second operation. The longest interval between the two operations was six years.

Kilgore,⁸ in an interesting paper published in 1921, found 37 instances of bilateral disease among 1100 unselected cases of cancer of the breast, and of these he regarded 13 as probably primary, because of the long interval, the absence of recurrence of the first tumour, and the good results following the second operation. Of these 13 cases, in 12 the interval was five years or longer. Kilgore quotes the Census Bureau Reports, giving the expectancy of cancer of the breast in women of different ages. The highest rate is between 35 and 45, when it is 1 in 52, or 2 per cent; whereas in women who live for five years or more after the removal of a cancerous breast the expectancy of cancer of the remaining breast is four times greater than the liability of all women of the same age to cancer of either breast.

When a woman is seen with carcinoma of both breasts and no evidence of metastases, the two breasts should be considered on the same lines as if they belonged to different individuals. If each is apparently operable, both should be removed—at the same sitting or not, according to the condition of the patient at the completion of the first operation. If, however, the disease on one side is inoperable, it will be of doubtful benefit to the patient to remove the more favourable one, and nothing should be done.

PREGNANCY AND CARCINOMA.

It may be noted that among the 16 cases of bilateral disease 3 occurred during the child-bearing period. I have in all had 20 cases in which the disease occurred in more or less close association with pregnancy and lactation. It is, I believe, universally recognized that in such circumstances the disease is likely to run a particularly rapid and malignant course, not fully explained by the necessarily lower average age of the patients, and in my own series there is no striking exception to this rule. The average age of the patients was 35.4 years, whereas the average age of 500 consecutive cases of cancer of the breast in University College Hospital was as high as 49.6.

As striking examples of extreme malignancy may be mentioned the following:—

Case 5.—Tumour noticed about two months before pregnancy; in four months the tumour was large, fixed, and inoperable; death in seven months with secondary deposits in skin, lungs, liver, and pelvis.

Case 6.—Tumour noticed in seventh month of pregnancy; in six weeks breast diffusely affected and fixed, and the patient very ill, with skin nodules and slight jaundice.

Case 7.—Admitted to University College Hospital under Sir John Rose Bradford on account of cough and slight fever occurring during lactation. As the breasts diminished in size, it was noticed that the left remained larger and harder than the right. Death occurred on the eighteenth day. There was a diffuse carcinoma of the left breast, with secondary deposits in the lungs and liver and in the axillary, mediastinal, and abdominal lymphatic glands.

The three cases of bilateral disease occurring during the child-bearing period were as follows :—

Case 8.—Lump in left breast removed locally by another surgeon ; it recurred, a tumour also appearing in the right breast. Eighteen months after the first operation both breasts removed. Pregnancy began three months later, and six months after the termination of pregnancy there were extensive local recurrences on both sides and signs of metastases in the chest.

Case 9.—Tumour of left breast noticed early in pregnancy : twelve months later there was extensive disease on both sides. Operation on the left proved incomplete, and therefore the right was not removed.

Case 10.—Left breast removed for carcinoma ; fourteen months later a tumour appeared in the right breast shortly before a miscarriage, there being no evidence of recurrence on the left side. Operation was performed, but the result is not known.

Henri Vignes,⁹ in an interesting article on “The Evolution of Cancer of the Breast during Gestation”, discusses the subject fully, and takes into consideration the course of the disease when appearing during pregnancy and lactation, and also the effect of pregnancy on a cancer previously present. He states that the occurrence of pregnancy after the removal of a cancerous breast is very often the signal for the appearance of the disease in the other breast. Trout,¹⁰ dealing with this aspect of the disease, records two cases in which a subsequent pregnancy occurred and each developed cancer in the remaining breast. From other surgeons Trout collected 15 cases of this kind, of whom no fewer than 13 had cancer of the remaining breast and 12 died very rapidly, the interval between the operation on one breast and the occurrence of the disease in the other varying from two to ten years. I have personal experience of only one case of this nature (*Case 10* above). The observations of Kilgore already mentioned suggest the necessity of caution in assuming too readily that the subsequent pregnancy takes an important part in determining the development of carcinoma in the remaining breast.

Altogether it seems to me difficult to picture a more tragic and pitiable example of malignant disease than that of cancer of the breast occurring in a healthy young woman in connection with pregnancy.

For purposes of comparison, I tabulated an equal and consecutive number of cases of carcinoma in women under forty years of age in which the disease did not occur in any relation with pregnancy. Of these 20 cases 8 died, probably all as the result of the disease, at periods varying from eight months to four years after the operation ; one died four years after operation from rheumatic pericarditis without signs of recurrence ; 6 were alive, but with signs of local recurrence or metastases, at periods varying from six months to four years. In one case the disease was inoperable four months after it was first noticed. Four patients only were known to be free from signs of recurrence fourteen months, two years, four and a half years, and six years after operation respectively. These results are sufficiently bad, and suggest that caution is necessary lest too great a share be assigned to pregnancy in explaining the unusually malignant course of cancer of the breast occurring in the child-bearing period.

CARCINOMA AND FEVER.

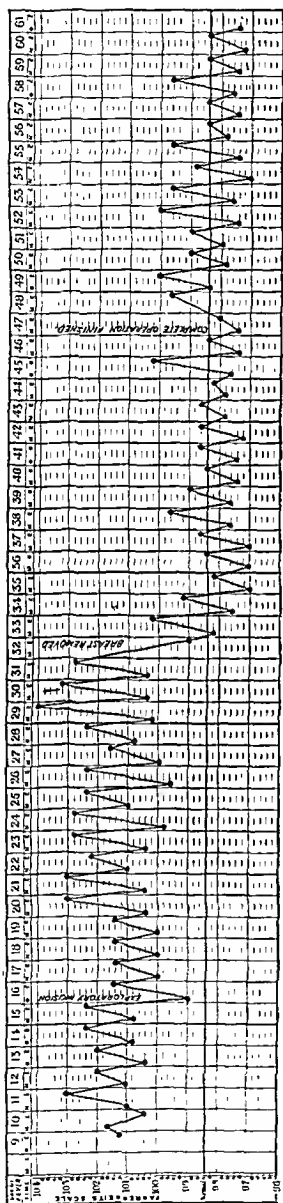


FIG. 370.—Chart showing fever in a case of carcinoma of the breast.

Before concluding, I should like to take the opportunity of recording a case in which a carcinoma of the breast appeared to be the cause of a considerable degree of fever. The patient, a widow, age 36, had noticed a lump in the left breast for six months, the increase in size being more rapid during the last six weeks. Eight days before her admission into University College Hospital she became feverish and unfit for work. There were no symptoms or physical signs to account for the fever, the course of which is shown in the accompanying chart (Fig. 370). Widal's reaction was on two occasions negative; a blood-count showed a moderate leucocytosis. The tumour in the upper and outer quadrant of the left breast had the characters of a rather soft carcinoma, the skin over it being attached and slightly reddened; several hard glands were palpable in the axilla. On the seventh day after admission (the sixteenth of the fever) an incision was made into the tumour in view of the possibility of a mistaken diagnosis; it exposed a soft solid growth, which proved on microscopic examination to be a very cellular spheroidal-celled carcinoma, the cells being unusually large and vesicular and showing very active mitosis (Fig. 380). The fever persisted, and on one occasion rose to 104° . On the twenty-fourth day (the thirty-second of the fever) the breast was removed. The temperature at once fell, and subsequently only twice reached 100° . Fifteen days later the complete operation was finished. Three years later the patient showed no evidences of recurrence. I have no comment to make on this case except that it is difficult to imagine that persistent fever due to some other and undiscovered cause and of four and a half weeks' duration should by an extraordinary coincidence have terminated abruptly on the very day on which the breast was removed.

It is to be regretted that a bacteriological examination was not made of the tissue removed at the exploratory operation.

Space will not permit me to refer to my personal results in the treatment of carcinoma of the breast, and perhaps it is as well. An American surgeon writing on this subject has remarked that "one of the most useful results of

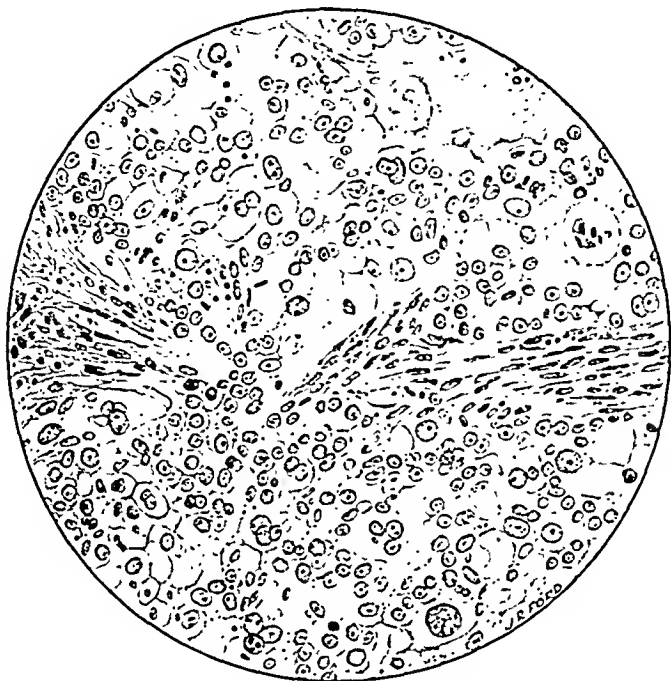


FIG. 380.—Carcinoma of breast, associated with fever.

an analysis of a series of operations for carcinoma of the breast is to lessen the conceit of the average surgeon". I feel quite humble enough at the conclusion of this lecture without going out of my way to produce a condition of utter abasement.

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CARCINOMA OF THE BREAST AND ITS METHOD OF SPREAD: EMBOLISM OR PERMEATION.

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THE usual text-book teaching about the spread of malignant disease is that the cells of a sarcoma spread by the blood-vessels, and the cells of a carcinoma by the lymphatics. That, however, is not the whole truth, and we shall find on examination that the cells of both forms of malignant disease are able to spread by both sets of vessels. Before dismissing sarcoma, with which it is not now proposed to deal, it may be stated that lymphosarcoma spreads constantly by the lymphatics, a fact stated in the alliteration that sarcoma of the testicle, thyroid, and tonsil spreads along the lymphatics. Perhaps the best example is the melanotic sarcoma; but I hesitate to mention this, because some observers class it as a melanocarcinoma, in which case we should expect it to spread by the lymphatics, along which it passes and infects the lymph glands, draining the affected area; if, however, it be classed as a melanocarcinoma, then it becomes one of the best examples of a carcinoma spreading by the blood-stream, as its distant metastases are obviously blood-borne.

Let us turn now to carcinoma proper. The recognized method of spread is along the lymphatics, but the spread by the blood-vessels sometimes is almost as important. To this surgeons pay little attention; indeed, some mention it only to deny its importance. How, then, do malignant cells get into the blood-stream, and what becomes of them there?

When carcinoma starts in the region supplied by the systemic circulation, in contradistinction to carcinoma starting in the region supplied by the portal circulation, the cells may gain access to the blood-vessels in two ways. They may find their way along the lymphatics, either avoiding the glands, or even passing through the glands when the lymphatic tissues are loose enough to permit this to be done, or in course of time eventually growing through the gland, and so enter the large veins at the root of the neck.

There is, however, an easier way emphasized by Goldmann, who insists that carcinoma can spread by the blood-vessels as well as by the lymphatics. Goldmann proved by microscopic investigation that the vessel walls become invaded by the cells of the growth carried to them by the nutrient vasa vasorum, which he stated were devoid of lymphatics. These cells increase and multiply in the vessel walls, especially below the intima of the veins. The cells eventually break through the intima into the lumen of the vessel, whence they can easily be carried into the general circulation. This has been confirmed by the investigations of many pathologists, and Dr. Kettle has well illustrated the condition in his book, *The Pathology of Tumours*, to which the reader is referred.

Of these two routes by which the cells may get into the blood circulation,

the blood-vessel route seems to be the easier, the earlier, and the more important, and the lymphatic route to be a later and a subsidiary one. This is borne out by the study of cancer in the alimentary canal in the region of the portal circulation. Here the cancer is so situated that the cells do not pass to the lungs—where we shall see later a large number get destroyed—but pass direct to the liver. The liver is infected as readily by cancer in the upper part of the portal system as it is by cancer of the rectum, so we may put out of court the possibility of loose cancer cells floating about the peritoneal cavity.

Now there is no lymphatic connection between the liver and the primary growth in the intestine, so that the route by which the cells spread must be the blood-stream, showing that growth into and through the walls of the blood-vessels must be a very important method of spread, at all events in the portal area. In carcinoma of the breast, however, secondary growths in distant organs are commoner than in other forms of cancer. This may mean that lymphatic infection is easier here—and, as we shall see later, this appears to be the case—or that the blood-borne emboli from the alimentary canal are all caught in the liver.

Now we must consider what becomes of the cancer cells when they have entered the blood-stream. There is a consensus of opinion, borne out by many experiments, that ordinary blood is unfavourable to the growth of isolated epithelial or carcinomatous cells, though favourable to that of connective-tissue or sarcomatous cells. The blood in the general circulation being unfavourable to the growth of cancer cells may explain some of the failures to graft cancer from one animal to another; but the investigations of Schmidt show that there is another serious bar to the growth of cancer cells, and that is the capillaries of the lungs, in which the cells must almost certainly be caught before they enter the general circulation. Once caught, a local infarct forms, the cell becomes surrounded by an area of thrombosis, the organization of which will either destroy the delicate cells or so encapsule them as to render them harmless and incapable of spreading. Sometimes, however, the cell growth may be so vigorous as to burst through and penetrate the thrombus and gain the small pulmonary veins, and so the general circulation, when the dissemination of the cells becomes possible.

Schmidt's investigations reveal: (1) That the embolic infection of the lungs is extremely common, though till lately almost unsuspected; and (2) That the majority of the emboli are destroyed in the lungs. In 735 cases of breast cancer the lungs were occupied by secondary growths large enough to be seen in only 70 cases. In most post-mortem examinations it is the pleura and glands at the root of the lungs rather than the lungs themselves which are affected to the naked eye. In Schmidt's cases the emboli were all microscopic, invisible, and unsuspected.

Thus we have two curious phenomena side by side: in the pulmonary circulation, infection of the lungs and destruction of most of the emboli; and in the portal system, infection of the liver and growth of the emboli. Why the liver favours the growth of the emboli is not known. It may be that the capillary arrangements are freer in the liver than in the lung; that an infarct does not form, so that there is no thrombosed tissue to organize round the

intruding cell and throttle it. On the other hand, it may be something in the portal blood which promotes the growth of the cell; or, lastly, it may have to do with the inactivity of the organ as compared with the lungs, which are constantly expanding and relaxing and preventing stasis.

Having seen, therefore, that most of the emboli are suppressed in the lung capillaries, and that only a certain proportion get through them, we must inquire what happens to those that do gain the general circulation. Probably many die on account of the inelement nature of the blood itself. It is only natural to suppose that the survivors are sown broadcast through the organs of the body, but we know that they do not grow everywhere in the body with equal facility. This, however, is what we should expect, for embryo life does not flourish equally well everywhere in Nature. Seeds, eggs, cuttings, all have a tremendous wastage even when incubated, if I may use the term comprehensively, in what are supposed to be the most suitable surroundings.

Stephen Paget, in 1889, in a paper on "The Distribution of the Secondary Growths in Cancer of the Breast", showed that, in 735 cases of cancer of the breast, the liver contained metastases in 241 cases, and the spleen in only 17; while in 340 cases of pyæmia, 66 abscesses occurred in the liver and 39 in the spleen. Paget pointed out that a purely mechanical theory of blood embolism could not account for this disparity in numbers, as the emboli should be sown broadcast and affect the two organs according to the amount of their blood-supply. What he failed to point out was that broadcast sowing did not explain what happened either in cancer or pyæmia, as the spleen, receiving far more arterial blood than the liver, should have had by far the larger number of abscesses.

Another factor, therefore, must come into play in the selection of the organ in which growth will take place. This factor is called the predilection or predisposition of the tissues. The predilection of the tissues has been denied, decried, and even ridiculed as something new and impossible to prove. But it is neither new nor difficult to prove. It is present throughout Nature, and well marked in almost all diseases which affect the human body. In the parable of the sower, which we can take as an analogy in Nature, we have predisposition best displayed; some seeds came to naught while others bore fruit, the reason for the want of fruition in each case being given; but the opponents of predisposition affirm that, because the seeds never bore fruit, therefore they were never sown—a totally erroneous deduction in the case of the parable as well as in the human body. They say that as metastases rarely occur in certain bones, therefore no emboli reach these bones. In other diseases of the body there are factors governing the appearance of these diseases which we cannot explain. Sex, age, and distribution can all be quoted to prove this. What is the reason, for example, that in infantile intussusception three times as many boys are affected as girls, at a date when there is no sexual differentiation? Or, again, why does congenital dislocation of the hip occur six times as often in girls as it does in boys, though it takes place in utero? This must be controlled in some way by sex. Why is it that ringworm and infantile palsy affect children, but rarely adults? Here age plays its part. Why is it that in pyæmia the abscesses appear far oftener in the joints than anywhere else? Why is it that gummata occur so frequently

near the knee and so seldom below the level of the calf? Why is it that the rash of chicken-pox is seldom seen below the level of the elbows and knees, while that of small-pox is characteristically displayed on the palms of the hands and soles of the feet? Surely this is distribution. If we hark back to the blood, why is it favourable to sarcomatous cells and unfavourable to carcinomatous cells? Have not almost all organisms a special predilection for certain tissues, so constituting special diseases? Take diphtheria, typhoid fever, and gonorrhoea, all caused by organisms which affect different mucous membranes. Has not every disease a predilection for special tissues, so constituting a special disease? Take for examples pneumonia, malaria, tetanus, and syphilis. Or, again, take the experiments of Levin and Sittenfeld in laboratory animals. They injected adenocarcinoma of the Flexner-Jobling type into the jugular veins, and found that growths appeared in the liver but nowhere else. Examples of these predispositions could be multiplied indefinitely. They show that predisposition of tissues is as well recognized and is as well established as anything we know of in medicine, though the reason for the predisposition is still hidden from us.

If, then, this predisposition is well established in other diseases, why should it not come into play in the problems of cancer, which we can explain in no other way? Cancer is a disease, too, that gives rise to secondary growths in distant organs by cells becoming implanted upon new tissues in the same way as seeds are grown in a hot-house, and these cells are therefore especially sensitive to favourable or unfavourable surroundings.

Stephen Paget came to the conclusion that in cancer of the breast "the bones suffer in a special way, which cannot be explained by any theory of embolism alone". Quite true; it cannot be explained by embolism alone; but this has been seized upon by those who favour other theories as evidence from Paget that embolism does not occur at all.

Not only does this predilection take place, but the different forms of cancer may have different situations which are favourable to their growth; for while the bones are frequently affected in cancer of the breast and thyroid gland, and, further, the bones of the skull are especially affected in growths such as hypernephroma, yet von Winiwarter found not a single instance of cancer in the bones in 903 cases of cancer of the stomach. For this predilection, however, there may be another explanation which is given later.

Alfred Piney, in a recent paper in *THE BRITISH JOURNAL OF SURGERY*, showed that only the red marrow of bones was affected, and not the fatty marrow, an observation which most pathologists will confirm. At the same time he pointed out that we have no evidence of any lymphatics in the bone-marrow. His sections show the emboli growing in the endothelial-lined spaces in the marrow. Piney rejects Handley's theory of permeation for bone infection, and the more one studies the occurrence of bone infection in breast cancer, the more convinced does one become that the infection of the bone can only be blood-borne. There is nothing remarkable in the fact that the bones of the distal segment of the limb escape any more than that the same segments of the limb escape chicken-pox and are seldom affected by gummata; yet no one assumes that the particular poisons of these diseases do not circulate through these areas. Nor do these segments of the limbs

invariably escape, for Dr. Kettle has given me particulars of a case of mammary cancer which had secondary metastases in the bones of the fingers, and the illustration (*Fig. 381*) shows a tibia recently added to the Museum of St. Mary's Hospital which is full of carcinoma secondary to an atrophic breast cancer. *Fig. 382* shows the infection of the liver in the same case.

Other cases might be quoted in which the secondary growths could only have been blood-borne.

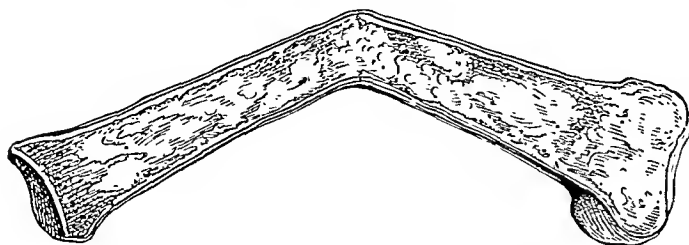


FIG. 381.—A tibia infected widely with secondary growths from an atrophic breast cancer. (*St. Mary's Hospital Museum 99, 7731.*)

Mr. Ernest Miles has given me particulars of a lady under his care who suffered from cancer of the rectum and who died suddenly from a secondary mass in the brain. No better example,

perhaps, could be adduced of blood embolism than the instance reported by Friedreich, where cancerous metastases were found in the knee of a fœtus whose mother died during the pregnancy from cancer of the liver.*

It is quite obvious, I think, to anyone with an unbiased mind, that such growths can only be due to blood embolism, though Handley tries to explain them by actual growth even against the lymph-stream. I hope to show later that cancer cells never do grow against the blood-stream, and that there is nothing in favour of such a happening. Cases, too, have often been reported where the metastases are in the brain and dura mater and must have been carried there by the blood-stream.

Now can we explain the frequency of metastases in the bones, the brain, or in situations to which the growths appear to be borne by the blood-stream in breast cancer, and the rarity of such occurrences in cancer of the uterus and the stomach?

If we compare these organs we find that in breast cancer the circulation is defended against embolism by at most two sets of glands, namely, the

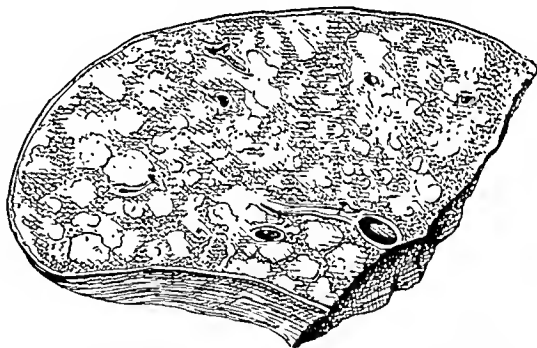


FIG. 382.—Section of a liver showing widespread infection by the blood-stream with small areas of growth by an atrophic cancer of the breast, from the same subject as shown in *Fig. 381*. (*St. Mary's Hospital Museum 37, 770.*)

* Since the above was written, Sir George T. Beatson has published (*Brit. Jour. Surg.*, 1925, Jan., 473) a "Case of Osseous Metastasis from Primary Carcinoma of the Right Mamma" which amply illustrates this point.

axillary, with sometimes a supraclavicular set in addition. All the lymphatics of the axilla do not, however, pass through the supraclavicular set; some pass direct to the thoracic duct before it enters the junction of the large veins, and some of the upper intercostal lymphatics pass to the lymphatic duct direct without passing through any gland: whereas in the stomach and uterus the general circulation is defended by many more stations of glands, and the whole length of the thoracic duct. Thus it is quite possible that access to the blood-stream via the lymphatics may be more easily attained in the case of breast cancer than in cancer in other situations. Hence we find metastases in distant organs in breast cancer, but not in cancer elsewhere.

In conclusion, therefore, we can say of blood emboli that they exist, and that they play a more important rôle than has yet been assigned them; that they flourish better in the portal than in the pulmonary and general circulation; that they are more commonly met with in cancer of the breast than in cancer of other organs; and that the peculiar tendency to bone metastases in certain forms of cancer can be ascribed to them.

Having dealt with emboli in the blood-stream, let us turn aside to consider the theory of lymphatic permeation. This theory was introduced about twenty years ago by Sampson Handley to explain the spread of cancer, and by it he still seeks to explain every phase and feature of the growth of the disease. The theory now has an established place among the teaching formulas of all medical schools. Its author has pursued the work and applied it to everything cancerous much farther than the facts seem to warrant: this point is illustrated by reading the explanation for Paget's disease of the nipple given by Handley in Choyce's *System of Surgery*, and then reading the investigations of Sir Lenthal Cheate published in THE BRITISH JOURNAL OF SURGERY on the same subject.

Sir Lenthal dissociates himself entirely from Handley's view of Paget's disease, and I think proves his points. Until Piney openly disowned Handley's theory the other day in regard to metastases in bone, no one, and more especially no pathologist, had taken the trouble to write upon the subject.

Let us now see what the theory is, on what it is based, whether the premisses are tenable, and fit the facts as the surgeon meets them. I hope to show that the premisses are false and that the theory in no way gives an explanation of the familiar phenomena found.

Shortly, the theory is that, though lymphatic embolism is admitted as taking place along the larger or main lymphatics (see Figs. 383 and 384), and blood embolism is not denied, neither is considered of first-class importance; but the main and important spread is said to take place along the medium-sized lymphatic vessels—not by embolism, but by actual growth or extension, or what is termed permeation of these vessels. "Cancer thus spreads in the parietal tissues by permeating the lymphatic system like an invisible annular ringworm. The growing edge extends like a ripple in a wider and wider circle, within whose circumference healing processes take place, so that the area of permeation at any one time is not a disc but a ring". Cancer therefore advances through the tissues by means of a "microscopic growing edge of carcinoma cells", which spreads farther and farther away from the primary

growth. This appears to Handley to be the "master process of dissemination". Having passed through the tissues, all the cancer cells disappear except those in the extreme outer ring, which continue to proliferate and spread. The disappearance of the vast bulk of the disease is brought about by a perilymphatic fibrosis which takes place round the blocked lymphatic, and by contraction destroys the cancer cells. In a few places, however, the growth of the cancer cells is so vigorous that they burst through the encircling and strangulating perilymphatic fibrosis, escape from the vessel, invade the tissues locally, and so set up a secondary nodule. But "no outlying embolic foci can be found outside the microscopic parietal growing edge of a breast cancer". Breast cancer is mentioned, but I take it that this applies to all forms of cancer.

Now on what is this theory based? Apart from clinical observations of certain cases which seem to suggest such a form of spread, which we need not consider—for among the thousands of cases of cancer observed yearly there is hardly any theory, however wild, which could not be illustrated by suitable and appropriate cases—the theory is based mainly upon two premisses: (1) That retrograde embolism by the lymph "cannot take place to any extent in trunk lymphatics on account of the valves in them", these valves only allowing the flow of lymph to pass in one direction, whereas cancer spreads freely in all directions. "It is independent of the current of lymph, and proceeds with almost equal facility either in the direction of, or against, the lymph-stream, a fact which affords the key to the clinical puzzle that cancer is often seen to spread in a direction contrary to that of the lymph-stream". (2) That "in whatever direction the cancer cells attempt to leave that (lymphatic) area, they find an efficient filter blocking the way", and that the vessels forming the filter are too small to allow the passage of the cells, and the current is too feeble to carry them along. Other arguments are used to persuade us of the truth of the theory based upon investigations made by means of microscopic sections; these, however, only show where the cancer cells lie, but not how they get there.

Cancer cells have no means of movement as yet known to us. It is obvious, therefore, that if they are not moved by the lymph-stream they must simply grow along the vessels by division in one plane. This apparently is accepted by Handley, for he says: "In the case of the cancer cells the driving force is an internal pressure resulting from their own proliferation". Now this is the method of growth that we suppose the primary tumour to possess; but even in the most rapidly-growing tumours this process is comparatively slow, and it is difficult to associate the process of growth with the metastases in distant organs, and at the same time accept the view that the enormous mass of cells which formed the connecting links have all disappeared, and left no trace of their passage or existence beyond here and there an isolated nodule of small size. But if this mass of cells has disappeared, together with the lymphatic vessel which originally contained the cells, how does the lymph leave the region, and why is not the whole area of skin turned to pig-skin, as it is in the places where we know the lymphatics are obstructed?

As no outlying embolic foci can be found outside the microscopic parietal growing edge, metastases in the brain are supposed to have reached this

situation by permeating the lymphatics of the carotid vessels, and to have entered the skull through the carotid foramen or foramen spinosum, complete disappearance of the connecting cells having taken place, although elsewhere the site of permeation is always in the deep fascia. This seems hardly likely.

Now to return to the two premisses laid down. First, we must consider the presence of valves and the supposed spread of cancer against the stream of lymph. These valves are best seen as small beadings on the vessels on attempting to inject the lymphatics. They offer a considerable but varying resistance to injection; but this can be overcome, and the famous old anatomist, Munro Secundus, was able to inject the whole lymphatic system of the body with mercury, including the smallest lymphatics of the limbs as well as the larger ones of the intestinal canal. The body is still on view in the Museum of the University of Edinburgh. The wonderful dissections the celebrated Charles Bell made of injected lymphatics are well worth seeing in the Museum of the Royal College of Surgeons of Edinburgh. In neither case have the valves prevented the injection of the vessels to their full extent. Further, we know, that when a physiological blockage of the main vessel takes place, the valves present no great obstacle to the back flow of lymph if collateral channels can be opened up. (Figs. 383, 384.)

Further, we know that in an ordinary case of scirrhus cancer the glands in the axilla become infected early, before secondary growths appear in the internal organs. These glands being infected, the passage of the lymph through them must be obstructed in its outflow; but the little lymph which leaves the breast will still leave it by opening up other routes in the usual way by which collateral circulation is opened up. Increased flow will therefore take place in the lymph channels accompanying the perforating vessels of the internal mammary artery, along the lymphatics accompanying the muscular phrenic, and the branches of the superior epigastric vessels. It is along these vessels and in these directions that most of the internal late or fatal metastases, which we know are not blood-borne, must take place. With the blockage of the main vessels, increased flow must take place in other

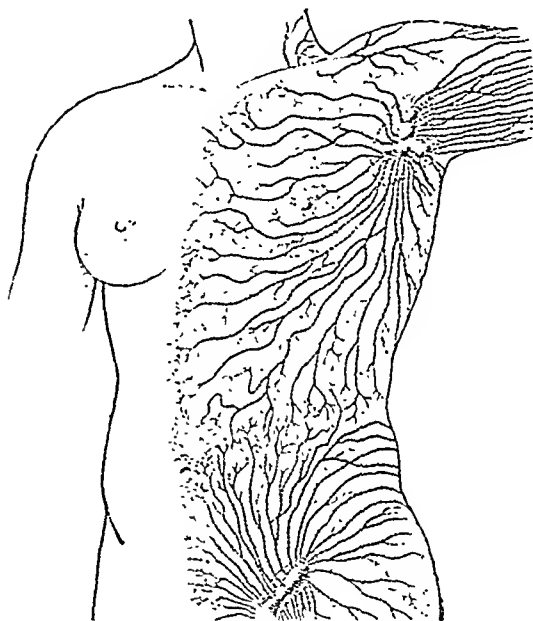


FIG. 383.—Sappey's 'vaisseaux lymphatiques', drawn originally from a man. This is not accurate for woman, and Fig. 384 shows better the lymphatic drainage routes. It leaves out the drainage to the breast itself and to the nipple plexus, which bears Sappey's name. It shows the watershed at the level of the umbilicus between the area which drains to the axilla and that which drains to the inguinal region, also the watershed of the mid-line.

directions, and the current may quite well be actually reversed in some of the vessels. The statement therefore by Handley that cancer grows against the lymph current is quite unproven, the whole weight of reason and evidence being against it.

The second premiss laid down, that the primary cancer is surrounded by a filter of such small vessels that the cancer cells cannot pass through it unless they pass through by the process of actual growth, and moreover that the current of lymph is too feeble to carry the cells through, can be proved equally erroneous. Handley illustrates this idea by a plate from Sappey which shows very well the three lymph areas of each side of the body and the very small inosculating branches which join each area to its neighbour. But this plate does not accurately represent our present knowledge, nor even the knowledge in Sappey's day, for Sappey's so-called plexus is not shown with the converging of the lymphatics towards the nipple; nor is there any indication of branches running into the anterior mediastinum along the internal mammary and muscular phrenic vessels, nor those accompanying the superior epigastric to the costo-xyphoid angle. But it is owing to Handley's insistence that the recognition of these last vessels as the route along which spread takes place is so largely due, and along these routes cancer spreads to the liver and the interior of the abdomen and chest. These are the vessels which we have just shown must enlarge, however small they may be to begin with, as the collateral circulation is opened up by the blockage of the axillary vessels. No one supposes that the fatal metastases take place through the very minute superficial vessels. The metastases which kill the patient are all in the internal organs. As time goes on and these vessels open up more and more, so does the likelihood and frequency of metastases occurring in the internal organs increase. What the actual size of these vessels at any given moment must be, or what the force of the current in them is, must be quite an unknown quantity, but I think it is reasonable to draw the conclusion that the lumen is larger and the current more active than it was originally.

This leads me to say something about the current of lymph which flows from the breast. From any organ the flow of lymph at any time is feeble. I doubt if it be rapid along the thoracic duct even after meals, although derived from such an extensive area and such large lymphatics as are in the twenty-five feet of intestine. We know that the actual blood-pressure has probably something to do with the flow of lymph, especially in internal organs such as the kidney; but no lymph flows from the limb of a resting dog. On movement of the limb, however, lymph does flow, but only in a moderate amount. Two reasons are given for this flow, one is the increased metabolism which takes place in the contracting muscles, which possibly has something to do with it; and the other is the pressure exerted upon the lymph-vessels by the contraction of the muscles, which must have a powerful propelling influence. Now let us consider the ordinary, non-pregnant, non-lactating breast—in other words, the resting organ.

Have we any reason to suppose that more lymph is going to flow from it than from the resting limb? On the contrary, the lymph-stream from the breast must be extremely feeble, for the following reasons. The breast is not active, and therefore increased metabolism does not come into play. The

breast does not lie between or under muscles which by their contraction can increase the flow of lymph by pressure on the organ, though doubtless the contraction of the pectoral muscles may help to some extent, by pressing on those lymphatic vessels which lie in and between them. The breast is not a vascular organ; the essential tissues of the breast, after activity, are absorbed, and their place is taken largely by fat, which is a singularly avascular tissue. So that when we find such statements made by Handley as permeation "only invading the large lymphatic trunks when the strong current which scours their channel has been arrested by the growth of cancer cells in the glands to which they lead", it becomes apparent that he entertains a view of the function of the breast lymphatics which is probably erroneous.

Now, supposing that Handley's supposition is true, and that the lymph-flow in these vessels has nothing to do with the spread of cancer, there does not appear to be any reason why cancer should quicken its growth in any way, supposing that the flow of lymph increased. But if embolism was the secret of the conveyance of the cells along the lymph-vessels, then naturally the quicker the flow the more rapid would be the spread. We will therefore turn to a lactating breast and note the facts.

Every surgeon knows that the life of an individual who is lactating with a carcinoma in the breast is a very short one. Not only does the growth spread with enormous rapidity through the breast itself, but internal and fatal metastases appear more rapidly than in other forms of the disease. Case after case could be quoted to prove this. Does this suggest permeation or embolism?

Now let us note the results of incomplete operations, and here again the verdict is unanimous. Imperfect operations in which the cancerous growth is cut into and the cells are spread in the tissues do great harm and help to spread the disease widely. But if the theory of permeation is true, how can this be, for the lymphatics in the neighbourhood of the primary growth are all supposed to have been destroyed by the destructive perilymphangitis? "The recognition of this process (perilymphatic fibrosis) at once removes the difficulty that permeated lymphatics are absent in the region immediately surrounding the growth".

If, on the other hand, the lymphatics are there, and are cut across, and the cancer cells allowed to escape into the tissues, and the lymph-flow is increased by the repair of the wound, then we should expect that both local and distant growths would result, and this is exactly what we find. Let us apply the theory elsewhere—to cancer in the lower bowel, for instance. Does the cancer spread down the bowel as well as infect the glands above it? Does cancer six inches up the bowel spread down to the anus and the inguinal glands? No, it does not, and the growing edge extending like a ripple in a wider and wider circle has no place here. Or take cancer at the anus itself, where again is the spreading ripple? Do we see metastases upon the thighs and buttocks, or do we find them only in the glands of the groin—in other words, in the direction in which embolism naturally takes place?

Wishing to make sure of my ground on this point, I wrote to Sir Charles Gordon Watson, Mr. Ernest Miles, and Mr. Lockhart-Mummery, to ask if they

had ever seen secondary growths on the buttocks or thighs or elsewhere than in the glands of the groin. They were unanimous in saying "No". Mr. Miles added he had never seen secondary growths even in the cruroperineal furrow. Is it not obvious, then, that cancer reaches the glands by embolism and not by permeation?

Or, again, consider cancer of the tongue or cancer of the lip, where we take out the growth and we take out the glands. No one attempts to remove a large circular area where supposed permeation has taken place: half an inch of sound tissue is deemed sufficient. The recurrences are all in the neighbourhood of the glands in the direction of the lymph-flow. In cancer of the tongue and of the jaw we know that the glands on the same side of the neck become infected, and later the glands of the other side. Is it not reasonable to assume that the glands on the same side become blocked, and as they become infected and the circulation to the other side then opens up, so the other side becomes infected? This is in no sense permeation, as the secondary growths seldom appear except in the glands.

Handley shows, in an admirable series of slides, the cancer cells growing in the lymphatics, which we would expect them to do wherever they lodge. He shows that some of them can be strangled by fibrous tissue and their spread prevented, and that some of the cells can even be destroyed; but that is only what we would expect; it is the process which we know goes on even in the primary tumour in the atrophic cases; but to have us believe that extensions all round to a distance of 20 in. from the tumour can be infiltrated so closely that cell touches cell all the way (for that is what permeation means), some spreading and some being destroyed, is to ask too much of our medical credulity, liberal though that certainly is. But the sections do not show anything like the destruction which is necessary to destroy the vast bulk of the cancer, in fact all, with the exception of the primary growths and the metastases, as Handley affirms. If the body defences are able to deal with nine hundred and ninety-nine parts of the cancer, why can they not deal with the odd thousandth more frequently than they do? Most of the sections show active proliferating cells, which again is to be expected in people who are dying in the last stages of the disease.

Turning now to what seems to me to be the most important fact in the spread of cancer, namely, embolic spread along the lymphatic vessels, all the arguments used against the spread by permeation point to the dissemination of the disease by embolism along the lymphatic vessels.

The percentage of cases in which the axillary glands are infected when the patient first comes to see the surgeon has been variously estimated: Shield puts it at 50 per cent, Gross at 64 per cent, and Bull at 65 per cent. Now these are palpably enlarged glands; but this does not mean that all were infected with carcinoma, as there is nearly always an accompanying mastitis which can cause a well-marked adenitis; on the other hand, there are many small infected glands high up in the axilla which are only found at the operation. Such being the case, estimation of the percentage of glands enlarged in the axilla is useless. What is important is the recognition that the infection spreads first along the lymphatic vessels in which the lymph-flow is most active. None would pretend that any other set of glands was infected so

early, so freely, or so often as those of the axilla, to which the ordinary flow of lymph is directed.

It is common to find one or two glands infected with growth low down in the axilla, and then no more till the very apex of the axilla is reached, where small suspicious glands can be felt which on removal are found to contain growth. These glands are infected through lymphatics which have passed up between the two pectoral muscles and have pierced the costocoracoid membrane and so entered the axilla. I have repeatedly found infected glands lying upon the costocoracoid membrane, on reflecting the pectoralis major muscle. Special stress was laid upon these lymphatics by Monard in his injection experiments. We therefore get two sets of glands infected with malignant cells, but no connecting link can be found between them. I believe the explanation to be that one set of glands becomes infected and the flow of lymph retarded; the growth in the gland eventually completely stops the

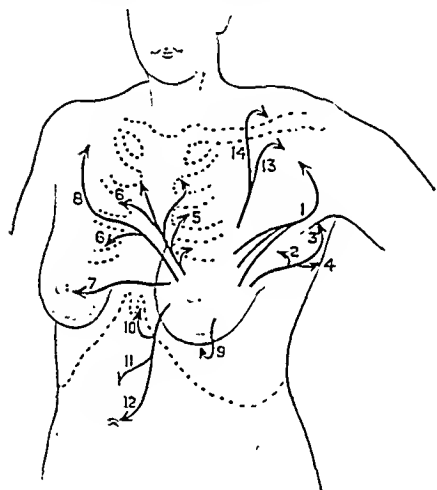


FIG. 351. 1, Main lymphatics to the axilla; 2, Lymphatics entering the chest wall at the point of emergence of the lateral cutaneous vessels; 3, Lymphatics along the subscapularis and latissimus dorsi muscles; 4, Lymphatics connecting with those at the back; 5, 6, Anterior perforating lymphatics of the same and opposite sides to the internal mammary trunk; 7, Communicating to the opposite breast; 8, Communicating to the opposite axilla; 9, Lymphatics accompanying branches of the musculophrenic vessels; 10, Lymphatics entering the dangerous angle to communicate with those of the internal mammary vessels; 11, Lymphatics entering the abdominal wall to communicate with those of the peritoneum and the superior epigastric vessels; 12, Lymphatics entering through the umbilicus to communicate with those of the peritoneum and along the ligamentum teres with those of the liver; 13, Lymphatics passing up between the pectorales muscles to the costocoracoid membrane and apex of the axilla; 14, Lymphatics passing directly to the supraclavicular region.

flow through that gland so that no further infection of the axilla can take place along this route. Meanwhile the collateral circulation opens up the channels between the two pectoral muscles, and the glands upon the costocoracoid membrane and very apex of the axilla become infected by cells carried by the lymph-flow. Thus we find glands affected in one place, then unaffected glands, and again infected glands beyond, the growth in the third set being always less than the growth in the first set, as the infection is more recent. It is only as time goes on, and as the axillary paths become more and more blocked, that the collateral circulation becomes opened up, that the cells are carried towards the middle line in such numbers that they grow in the liver, peritoneal cavity, and mediastinum, and so cause the death of the patient. In this way the patient is protected for a variable period of time against cancerous cells.

Sometimes two other late manifestations of the disease are also seen: one is cancer in the opposite breast, and the other is cancer in the opposite

axilla. In each case we know that there is a lymphatic path along which the cells may travel when the collateral circulation is opened up sufficiently; but that takes time; hence the late appearance of the growths in these situations. In permeation the opposite breast is as near and as accessible as the axilla on the same side, and the one should be infected as frequently and as soon as the other.

Fig. 384 shows that all the routes depicted there as opening up after blockage of the main axillary vessels are those along which we do find clinically that the carcinoma cells spread in a more and more marked manner as the disease gradually obtains mastery over the individual. This is what we should expect by carrying the embolic theory to its logical conclusion, and it is not necessary to introduce a new factor such as permeation.

I have not mentioned a factor about which very little is known at the present time, and that is the defensive powers of resistance of the individual. These are marked in some cases, and may prolong the fight for many years, only to break down as a rule in the end. Once this power of resistance begins to weaken, it disappears very rapidly. Whether this power resides in the lymph as well as in the blood, and what ratio it bears to the virulence of the growth, is unknown. Whether even the power of resistance gives way or virulence becomes more marked on the part of the growth, is a matter for mere speculation.

A CASE OF FAT NECROSIS OF THE BREAST.

BY GEOFFREY KEYNES. LONDON.

THE condition known as 'fat necrosis of the breast' was first reported by Drs. B. J. Lee and F. E. Adair to the American Surgical Association in 1920.¹ Two cases were then described. Three further cases were reported by the same authors in 1922.² Attention was drawn to these reports by Professor Choyce in 1922.³ but as far as I know no case has yet been described by any surgeon in this country. As will be seen, however, the condition has a definite clinical importance, and it will therefore be of interest to describe in some detail a case operated upon at St. Bartholomew's Hospital in 1924.

It will be well to emphasize at the outset the fact that fat necrosis of the breast is not a lesion of the mammary gland proper. It is a lesion of the fat which overlies, or infiltrates, in later life, the mammary gland, and its clinical importance lies in the closeness with which it simulates certain true breast lesions, especially carcinoma of the breast.

The history of the case here described is as follows:—

The patient was a monthly nurse, a spinster, age 50. On Feb. 21, 1924, she first noticed a tenderness in the left breast and a small lump. She does not remember sustaining any injury which might have accounted for it.

On Feb. 28 she was seen at St. Bartholomew's Hospital and was referred to the Surgical Unit by Dr. Malcolm Donaldson from the Gynaecological Department. She was a very stout woman with large breasts. In the upper and outer quadrant of the left breast near the periphery was a hard, tender nodule $\frac{1}{2}$ to $\frac{3}{4}$ in. in diameter. The lump seemed to be continuous with the mammary gland, and it was definitely attached to the skin, which was slightly dimpled over it. Its outline was somewhat indefinite. The lump was situated at some distance from the nipple, which was not retracted. No enlarged lymphatic glands could be felt in the axilla or elsewhere. A diagnosis of carcinoma of the breast was made without hesitation, the local signs conforming in every particular to those of a carcinoma. The patient was examined by three other surgeons, who agreed as to the diagnosis.

On March 7 an operation was done. I first cut into the lump to obtain confirmation of the diagnosis by fresh section. The incision revealed small white areas extending from just below the skin into the mammary gland, and surrounded by a zone of infiltration. A frozen section showed large polyhedral cells apparently lying in alveoli. These cells were not quite like the usual type of carcinoma, being even larger than the unshrunk cells seen in fresh sections; but the appearance was not recognizable as anything else, and the diagnosis was taken to be confirmed. A complete amputation of the breast with the pectoral muscles and the axillary fat was performed.

Subsequent examination of the specimen with paraffin sections revealed

the appearances seen in the accompanying figures. *Figs. 385 and 386* show one of the white areas under two powers of magnification. *Fig. 385* shows necrosis in fatty areolar tissue. *Fig. 386* shows that there is some infiltration

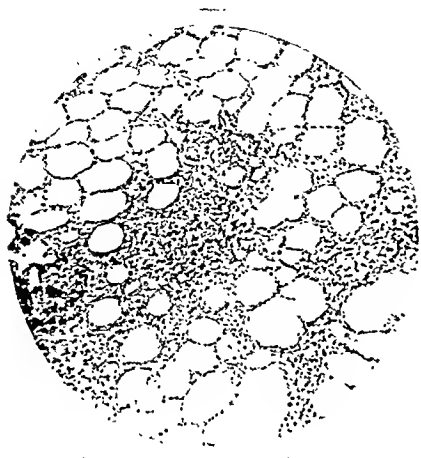


FIG. 385.—Necrosed area in fatty areolar tissue. ($\times 40$.)



FIG. 386.—Necrosed tissue, showing invasion by leucocytes and polyhedral cells at the periphery. ($\times 100$.)

of the necrosed tissue with leucocytes, and that at the periphery are some of the large polyhedral cells seen in the fresh section. *Fig. 387* shows a higher

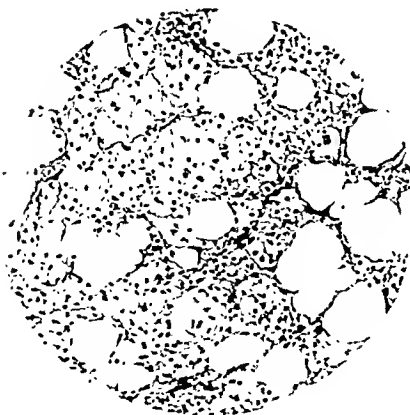


FIG. 387.—Multiplication of polyhedral embryonic fat cells outside the necrosis. ($\times 125$.)

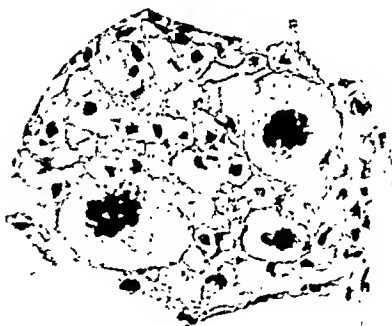


FIG. 388.—Embryonic fat cells with a group of multinuclear giant cells. ($\times 330$.)

magnification of an area containing large numbers of these cells, which have been identified for me by Sir F. W. Andrewes as embryonic fat cells. *Fig. 388* shows another area containing three multinucleated giant cells,

which were found scattered about throughout the affected area and seem to be a characteristic feature of the lesion. *Fig. 389* shows a high magnification of a single giant cell, which demonstrates clearly the fact that the nuclei are placed centrally rather than round the periphery. There was no blood pigment to suggest that the lesion was the remains of a hematoma. There can be little doubt, however, that the necrosis is of traumatic origin and that the occurrence of embryonic fat cells and giant cells is consequent upon the irritation produced by the necrosed tissue. The underlying mammary tissue showed normal atrophy without any pathological changes.

A history of trauma was obtained in every one of the five cases reported in America. In two the trauma was due to blows; in three it was produced by subcutaneous saline infusion given during previous operations. The resulting tumour was considerably larger in all these than in the present instance. A photograph of one of them taken before operation and reproduced in the second communication,² shows very well the dimpling of the skin over the tumour.

There are already a sufficiently large number of pitfalls to be encountered in diagnosing carcinoma of the breast. I have here drawn attention to another one. It is clear that a history of injury, especially that inflicted by subcutaneous saline infusion, should put the surgeon on his guard. In the present case no history of injury was obtained, and the cause of the necrosis is unexplained. Secondly, the macroscopic appearance of the lesion is suggestive. I now realize that the chalky whiteness of the necrosed areas, resembling the 'fat necrosis' seen in acute pancreatitis, should have suggested the true diagnosis. Thirdly, the microscopic appearance would not, I hope, deceive me a second time. The presence of embryonic fat cells would at once suggest that search should be made for multinucleated giant cells with central nuclei, though it must be admitted that a final diagnosis can scarcely be attained by fresh section alone.

I am indebted to Professor Gask for permission to publish this case. The microphotographs have been made by Miss Vaughan, Dunn Laboratories, St. Bartholomew's Hospital.



Fig. 389.—Giant cell, showing arrangement of nuclei. ($\times 550$.)

REFERENCES.

- ¹ *Ann. of Surg.*, 1920, lxxiii, 188.
- ² *Surg. Gynecol. and Obst.*, 1922, xxxiv, 521.
- ³ *Med. Sci. Abst. and Rev.*, 1922-3, vii, 214.

GASTRIC ULCER AND GASTRIC CARCINOMA:**AN INQUIRY INTO THEIR RELATIONSHIP.***

By J. HENRY DIBLE, MANCHESTER.

ORIGIN OF THE INQUIRY.

THE paper here presented owes its inception to a discussion which arose at a meeting of the Manchester Pathological Society held on April 21, 1920. Very divergent views were there expressed as to the relationship which existed between gastric ulcer and gastric carcinoma, and at the suggestion of the president, Professor H. R. Dean, "it was agreed that the subject was of such importance that a sub-committee be appointed to investigate into the incidence of malignant disease arising in ulcer of the stomach, and that the following be asked to constitute such a sub-committee: Dr. J. H. Dible, Dr. G. J. Langley, Mr. J. Morley, Mr. H. H. Rayner, and Mr. Garnett Wright" (Minutes of the Society). This committee met shortly afterwards and drew up a memorandum, which was circularized to the surgical staffs of the Manchester and Salford General Hospitals, requesting them to place their material at the disposal of the sub-committee. The request was generously acceded to, and grateful acknowledgement must be made to the undermentioned for their kindness in facilitating this inquiry by placing their material and the notes of their cases at our disposal: Mr. A. H. Burgess, Mr. W. R. Douglas, Mr. W. H. Hey, Mr. E. E. Hughes, Mr. G. Jefferson, Mr. J. Morley, Mr. Howson Ray, Mr. H. H. Rayner, Mr. C. Roberts, Mr. E. D. Telford, Mr. P. R. Wrigley, Mr. Garnett Wright; as well as to Drs. G. J. Langley, G. E. Birkett, E. Ratner, and B. J. Ryrie, for certain specimens.

Material from these sources was rapidly accumulated, and at a later date the sub-committee appointed Dr. J. H. Dible and Mr. John Morley to investigate it. The pathological work has been carried out by the former, whilst Mr. Morley collected and tabulated the clinical data. The final report was presented to the Manchester Pathological Society on May 14, 1924, and the main findings are now published by Dr. J. H. Dible at the request of the sub-committee.

SCOPE AND METHODS OF THE INQUIRY.

It is hardly necessary to recapitulate the many statements which have been made with regard to the general question of the relationship of gastric ulcer to gastric cancer, as their trend is well known. Nor is it likely to be disputed by any pathologist of experience that cases occur from time to time where the findings all seem to point to the likelihood of a chronic ulcer becoming

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cancerous. The position which it is the especial object of this investigation to examine more closely is the extreme one, first expressed by Zenker and later taken up by Robson¹ in this country, and especially emphasized in America and reflected in the teaching of the Mayo Clinic,² that a very large number of cases which reach operation with a diagnosis of chronic gastric ulcer show malignant changes, and that, therefore, the common fate of a chronic ulcer is the ultimate supervention of malignancy. This teaching, of which the histological basis has been presented and often reiterated by Wilson, McCarty, and their supporters,³ has in many cases been acceded to in this country, often, we think, without any very close personal pathological investigation or adequate review of the grounds on which the opinion is based. This acceptance is not by any means universally the case, and the main object of this work has been to re-examine the whole question with an open mind, by making as thorough an investigation as possible of the pathological material available.

The present paper embodies the results of work which was commenced in April, 1920, and has been going on continuously up to the time of writing. It has necessitated the examination of about 170 specimens and the making and examining of more than 600 slides. The material dealt with consists almost exclusively of specimens removed at operation, only a few post-mortem specimens being introduced to illustrate certain points, or conditions not often available in surgically removed material. The specimens were generally sent to the laboratory, unfixated, upon the day of removal, and were then packed with cotton-wool and fixed in Kaiserling's solution in as natural a state as possible. When hardened, the gross specimen was slit open and either photographed or roughly drawn, the sites from which blocks were removed being marked to render subsequent reference easy. The blocks taken were as representative of the lesion as possible. In an investigation of this sort wide tracts of tissue must be examined, and it has been our practice to include the whole of an ulcer, where one was present, in at least one plane, and in most cases additional blocks from the edges were also taken. In the case of malignant growths the whole base of the growth was examined, and the common site of ulcer formation was invariably included in the portion removed for sections, when this was involved in the tumour. Glands from the vicinity of the lesions were also subjected to examination as a routine practice. In each case the surgeon furnished clinical notes, upon a form which was supplied to him, and stated what the diagnosis had been prior to operation, and whether the condition found at operation confirmed this or caused any change of opinion.

The pathological inquiry has followed two main lines:—

I. It has been directed toward ascertaining what proportion of cases diagnosed as simple ulcer showed malignant changes—a proportion given by some of the writers to whom we have made allusion as between 60 and 70 per cent.

II. Evidence of pre-existing ulcer has been sought in cases which were definitely cancerous; the decision as to malignancy being arrived at from the combined evidence of clinical history, operative appearances, and the pathologist's opinion when the stomach was opened.

I. MALIGNANT CHANGES IN CHRONIC ULCERS.

With regard to the first problem, What percentage of gastric ulcers show microscopic evidence of malignancy? It is necessary to make it quite clear that in the class of 'gastric ulcers' we here include only those cases in which the pre-operative diagnosis was one of *simple chronic ulcer*, in which this opinion was confirmed at operation, and in which the pathologist, when viewing the specimen prior to microscopic examination, saw no evidence of malignant disease. Consequently we are not concerned with obvious errors of diagnosis, where the history and clinical symptoms lead to a diagnosis of ulcer, but where pathological examination clearly proves the condition to be simply, solely, and obviously carcinoma. The type of case we are now dealing with is that in which the diagnosis of ulcer has been made clinically, and remains the diagnosis up to the time of histological examination, when evidence of carcinoma is discovered. It is in cases of this class that various writers find high percentages of malignant change. A little consideration will show that the accuracy of such claims must be doubted on *a priori* grounds. For if 60 to 70 per cent of gastric ulcers are found to be malignant when taken at random and examined at one given period—ulcers whose duration may spread over as much as twenty or thirty years—then, when it is considered that the duration of gastric cancer will be at the outside probably not more than three years, it follows as a mathematical necessity, if this percentage be correct, that practically every gastric ulcer of long duration must in the end become malignant. This is entirely contrary to clinical experience, and such a supposition is further refuted by the acknowledged existence and long persistence of ulcers without malignant change that are found as causal agents in hour-glass stomachs.

RESULTS IN GASTRIC ULCER CASES.

With regard to the actual histological findings: in the present series of 126 ulcers in which the clinical and naked-eye evidence pointed to simple ulcer, the histological diagnosis has confirmed this; in fact, the present inquiry, to one out of touch with surgical cases, has been something of a revelation of the accuracy of present-day surgical diagnosis. Thus the result which has been arrived at in this part of the investigation is that none of this considerable series of gastric ulcers shows any malignant change. This is so strikingly in opposition to the weighty opinion of the authorities we have quoted that it demands detailed examination. The main explanation is probably to be found in the histological details to be reviewed immediately; but it must be pointed out that it is possible that some writers would include in the series of ulcers we have been referring to cases of carcinoma in which the diagnosis has been one of, 'simple ulcer becoming malignant', or 'ulcer. (?) carcinoma'. Such cases, *where there has been a definite suspicion of malignancy*, we have classed as carcinoma. Had this method of classification not been used, and such cases placed in our list of ulcers, the result would have been the finding of malignant disease in about 4 per cent. This figure is a small one, and obviously not sufficient to account for the discrepancy. It must further be pointed out that such a change in classification would

also have had the effect of lowering the number of cases of gastric cancer in which evidence of pre-existing ulcer has been found (*see below*).

It is necessary, when combating the statements of others, to find the source of their conclusions if these are held to be erroneous. The gist of the matter probably lies largely in the interpretation of small downgrowths of epithelium which are not uncommonly found near the edge of a chronic ulcer. This opinion is by no means a new one, since it was suggested by Ewing¹ in 1918, and has also been noted by others.⁵ It seems, however, that the matter needs emphasizing. These downgrowths, we believe, are only part and parcel of the general distortion of the tissues which takes place

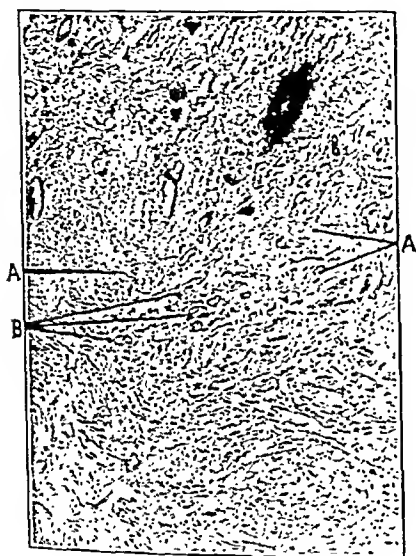


FIG. 390.—Epithelial dislocation in a healing ulcer. Note the general irregularity of the epithelium, and isolated acini (B) lying amongst and beneath the fibres of the muscularis mucosæ (A) ($\times 30$.)

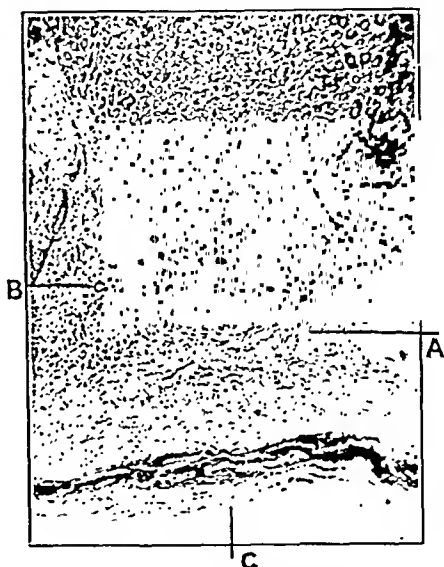


FIG. 391.—Displaced epithelium in a healed hour-glass stomach. A, Remains of longitudinal muscle. B, Epithelial tubules lying in muscle; C, Peritoneal coat. ($\times 30$.)

when healing occurs, and in a large number of chronic ulcers there is evidence of healing at one part or another. Some of these epithelial displacements (which were found in 32 per cent of the cases in this series) are illustrated in the accompanying microphotographs. Fig. 390 (Case 10269, Mr. Hughes) is taken at the edge of a healing ulcer, and shows epithelial tubules lying deep amongst the fibres of the muscularis mucosæ and in close proximity to the circular muscle. The condition is also well illustrated, in a healed lesion, by Fig. 391 (Case 24.79, Mr. Burgess), which represents a completely healed area in an hour-glass stomach. Here the musculature is represented by a few isolated fibres, and the epithelium is lining a crypt which approaches very close to the peritoneal coat. Isolated epithelial tubules are seen scattered through the scarred area. It is significant that these appearances are found

chiefly in healing areas, and it has been a recurring experience in the present work that it is fairly common to find them in scarred portions of the stomach the seat of past ulceration, or in hour-glass constriction the result of ulcer, neither of which conditions is, we believe, commonly accused of being the source of cancer. The epithelial tubules shown in the figures are obviously out of their normal relationship, but these relationships have been destroyed by the ulcerative process, and when healing occurs, the epithelium—which regenerates readily, whereas the muscle does not—tends to dip into the crevices on any surface which it is recovering. Sometimes the distortion which accompanies healing results in the production of epithelium-lined clefts of quite considerable size which run in unforeseen directions, and it may happen that the appearance produced in a single section which crosses the tip of one of these is that

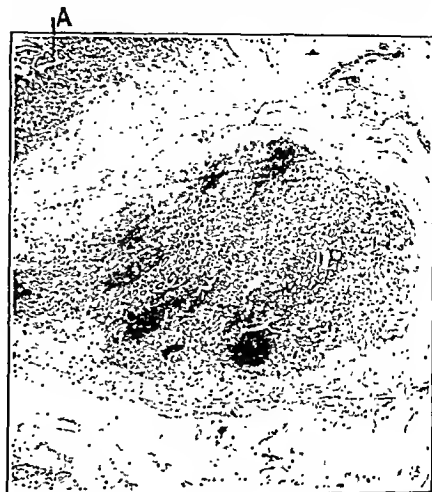


FIG. 392.—Isolated islet of epithelium—the tip of a crypt—in a healed hour-glass stomach. A, Surface epithelium. ($\times 12$.)

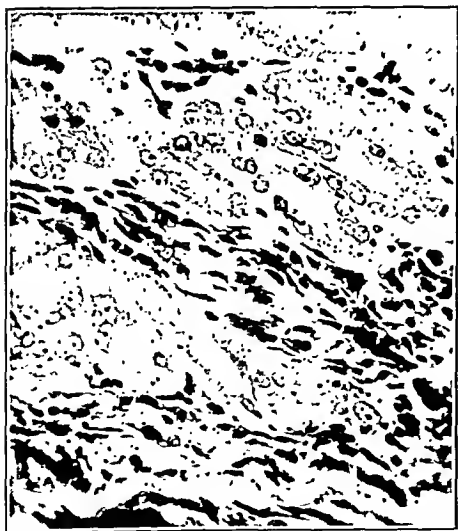


FIG. 393.—Proliferating epithelial tubules lying amongst the fibres of the muscularis, near the edge of an ulcer. ($\times 270$.)

of an islet of epithelium lying deep in the healed area; such an appearance is confusing, but serial sections will clear up its exact nature. Fig. 392 (Case 24.79, Mr. Burgess) illustrates an example of this occurrence.

Occasionally appearances such as those we have been describing give rise to real difficulty in interpretation. In the example illustrated by the next case it has not been easy to make up one's mind as to the meaning of the epithelial dislocation. The section is taken from the edge of a chronic lesser-curvature ulcer (Fig. 393, Case 22.300, Mr. Burgess). A high-power photograph shows some gland tubules of a rather proliferative type dipping and penetrating fairly deeply into the subjacent tissue, reaching below the level of the muscularis mucosæ, which is destroyed in this area. The general appearance of the tubules, the fact that they give the stain for mucin—

indicating a functional as well as a proliferative activity—and, in particular,

the condition of the stroma, rich in plasma-cells and in which fibroblasts are arranging themselves in orderly fashion around the termination of the tubules, have led to a decision to include this case in the simple-ulcer category. It is believed that it represents the active stage of the process which has been shown in the finally healed state in *Fig. 391*. (The after-history of this case shows the patient to be alive and in good health seventeen months after operation.)

It is therefore concluded, upon histological grounds, that in all of the present series of cases in which the clinical facts and macroscopic appearances have led to a diagnosis of gastric ulcer a simple and innocent type of ulcer has been present. Malignant changes have not been found. Further evidence of an indirect nature has been adduced which is against the likelihood of a large proportion of excised ulcers showing malignant changes.

II. EVIDENCE OF PRE-EXISTING CHRONIC ULCER IN GASTRIC CANCERS.

The second question which has engaged our attention is: What proportion of undoubted cancers show evidence of an ulcerous origin? This is by far the more difficult problem, and, before proceeding directly to the evidence,

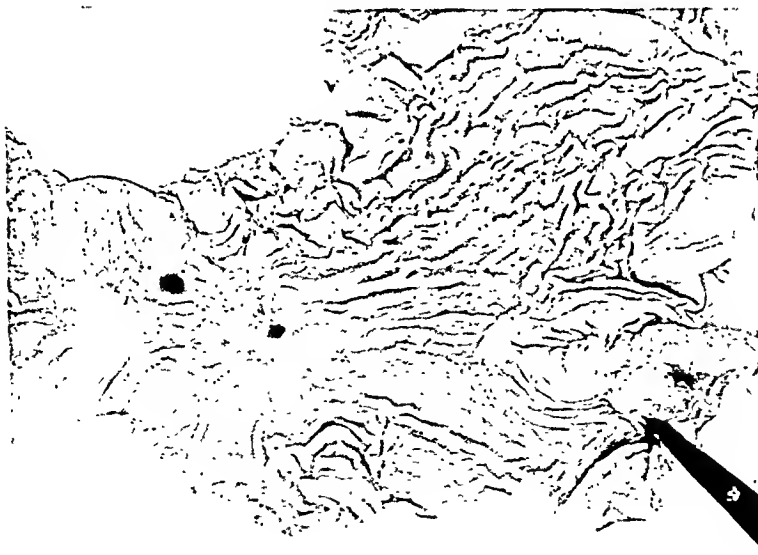


Fig. 394.—Stomach from a case of uræmia, showing acute and hæmorrhagic erosions.

it is necessary to survey the features of ulceration of the stomach as seen from the view-point of morbid anatomy, and to ask what criteria we can depend upon as giving sure evidence of previously existing ulcer. It is with this object in view that certain features of gastric ulceration are now to be

considered. For a full and detailed résumé of the histology of gastric ulcer the reader may refer to a recent and admirable exposition of the subject by Stewart, of Leeds.⁶

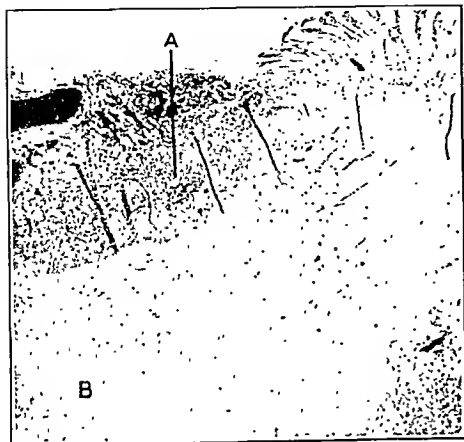


FIG. 395.—Hæmorrhagic erosion. A, Hæmorrhagic eschar; B, Edematous and infiltrated submucosa. ($\times 10$.)



FIG. 396.—Acute ulcer. A, Submucosa; B, Circular muscle; C, Longitudinal muscle. ($\times 12$.)

CHARACTERISTICS OF GASTRIC ULCERS.

The simple ulcer appears under various forms which roughly depend upon its age and extent. The earliest example is the hæmorrhagic erosion,

a condition uncommonly seen surgically but not infrequently met with in the post-mortem room. Fig. 394 (Case 10556, Dr. Ratner) illustrates a series of such erosions in the stomach of a patient dying of uræmia. The lesion is confined to the mucosa (Fig. 395), which is destroyed and replaced by a firm eschar of effused blood, and to the submucosa, which is infiltrated with leucocytes, an acute inflammatory reaction probably due to an infective origin. The

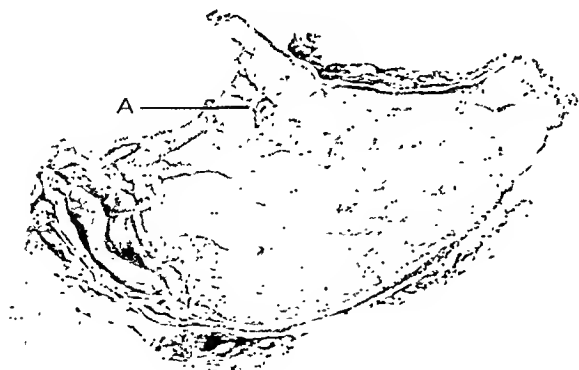


FIG. 397.—Small chronic lesser-curvature ulcer. A, Ulcer, which appears on the anterior wall owing to the opening out of the specimen for photographing.

next stage in severity, and also one which is not often seen in surgical material,

is well illustrated by *Fig. 396* (*Case 22,260, Mr. Douglas*), which shows a section of an ulcer removed at operation from a woman, age 62: the patient had a two months' history of gastric trouble, which, taken into consideration with her age, suggested malignancy. The shortness of the history is evidently to be accounted for by the acuteness of the ulceration, for the specimen shows an excellent example of acute ulcer, involving mucosa and submucosa only, and sparing muscle.

Chronic ulcers, with which we are more especially concerned—since it is only in connection with them that the question of cancer arises—may be classed for descriptive purposes, in order of severity, into: (1) Those without much fibrosis or distortion; (2) Those with considerable fibrosis and distortion; and (3) Those involving other organs. *Fig. 397*

(*Case 10058, Mr. Garnett Wright*) well illustrates the variety which produces



FIG. 398.—Small chronic ulcer. A, Necrotic debris in floor of ulcer; B, Stomach musculature; C, Fibrous base of ulcer. ($\times 10$.)



FIG. 399.—Lesser-curvature ulcer, causing deformity of the hour-glass type, seen from behind. A, Ulcer.

little alteration in the configuration of the stomach, and *Fig. 398*, which is a section from this same case, shows a portion of the edge of this ulcer

under a low power; it is to be noted that although this is only a small ulcer the muscular coat is completely destroyed. A more chronic type, with distortion, is illustrated by *Fig. 399* (*Case 22.516*, Mr. Hey), in which the duration of gastric symptoms was eighteen months; here it is possible to note, even with the naked eye, the complete destruction of the muscular coat. In almost identical specimens from other cases the duration of symptoms has been as long as thirty years, exemplifying a recurring experience that the length of history is no invariable criterion of the extent of the pathological lesion which may be expected.

In other cases different features are prominent. There is often a great deal of proliferative fibrosis distributed throughout the submucous coat. This is seen to a moderate extent in *Fig. 400* (*Case 22.484*, Mr. Garnett Wright), in the case of a partly healed lesser-curvature ulcer. The photograph shows the white fibrous scar interrupting the muscular coat in the region of maximum change, and the oedematous infiltration of the submucous coat, mainly on the posterior wall in the vicinity of the lesion, in which the fibroblastic proliferation is actively going on. *Fig. 401* (*Case 10342*, Mr. Morley) illustrates an extremely callous ulcer with an

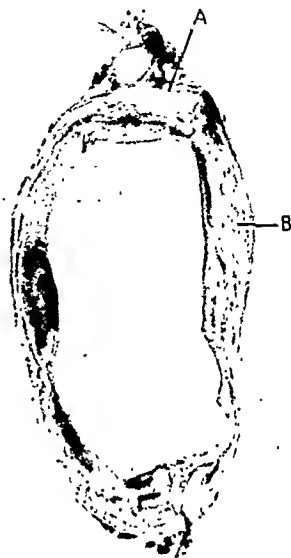


FIG. 400.—Section across the stomach to show infiltration of the submucosa in the vicinity of an ulcer. A, Scar of partly healed ulcer; B, Oedematous and fibrous thickening of submucosa, on the posterior wall. Note the sentinel gland close to the base of the ulcer.



FIG. 401.—Large lesser-curvature ulcer with chronic perforation and enormous production of oedematous scar tissue, both in the submucosa and gastrohepatic omentum. Specimen seen from behind, the stomach being opened coronally.

extra-gastric pocket and extreme œdematous infiltration of the submucosal and extra-gastric tissues: this is entirely innocent. Ulcers are sometimes

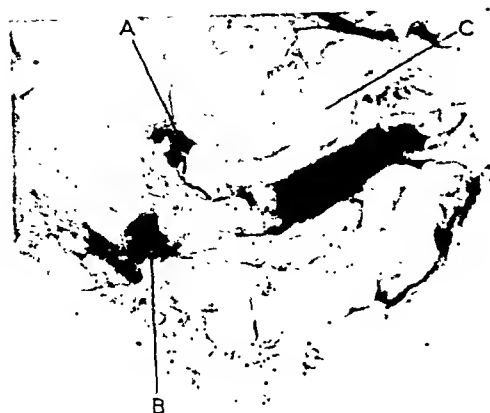


FIG. 402.—Lesser-curvature and anterior-wall ulcers in a stomach. Note the tremendous submucous infiltration seen in the posterior wall. A, Lesser-curvature chronic ulcer; B, Anterior-wall subacute ulcer; C, Infiltrated posterior wall.

double and sometimes of a spreading type, healing in one area and extending serpiginously in another. *Fig. 402 (Case 22, 520, Mr. Wrigley)* shows two ulcers, a deep indurated one on the lesser curvature and a shallower one on the anterior wall. The posterior wall of the stomach shows tremendous submucous infiltration and fibrosis.

The more extensive and chronic types of ulcer frequently involve related organs. *Fig. 403 (Case 9944, J. H. D.)* shows a large ulcer penetrating the liver deeply, and *Fig. 404 (Case 22, 753, J. H. D.)* an ulcer penetrating to the pancreas, whose white lobulated structure is seen in its

floor and may suggest nodules of tumour growth to the unwary; this particular ulcer had attained close proximity to the splenic artery.

With regard to the microscopical appearances of chronic ulcer: we usually find a sharply-cut breach of epithelium bordering a crater which is floored with some necrotic material; beneath this lies a mass of more or less highly organized fibrous tissue which extends right through the coats of the stomach, completely interrupting their continuity. *Fig. 405 (Case 22, 484, Mr. Garnett Wright)* illustrates this well. The edge of the ulcer is seen to the right, and below it is the muscular coat, which is sharply interrupted by a mass of inflammatory fibrous tissue covered by necrotic debris and containing thickened blood-vessels. We would particularly emphasize the

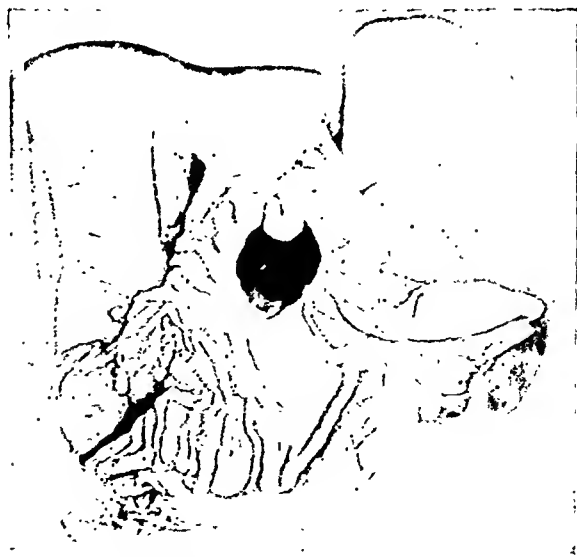


FIG. 403.—Large chronic ulcer penetrating the liver. Death from hæmorrhage.

floor and may suggest nodules of tumour growth to the unwary; this particular ulcer had attained close proximity to the splenic artery.

completeness with which the muscular coat is destroyed in chronic ulcer; it is a practically constant feature, having been found in 96 per cent of our

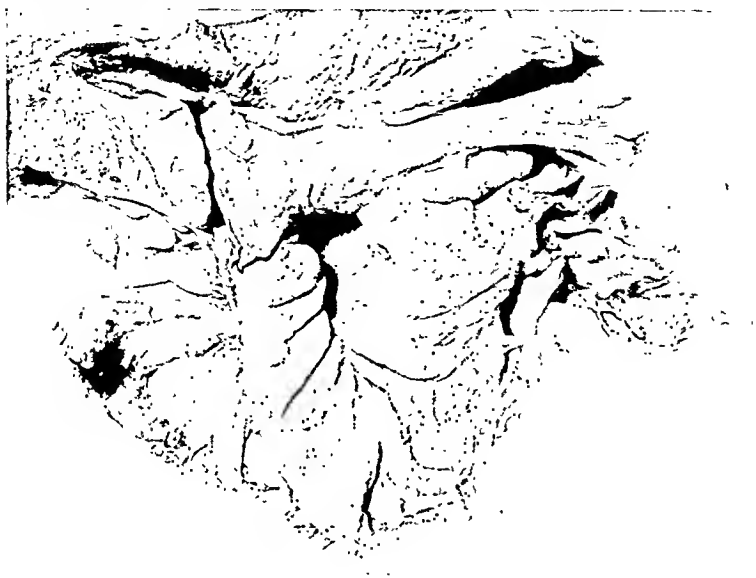


FIG. 404.—Chronic ulcer penetrating to pancreas. Nodules of pancreatic tissue are seen in its floor.

cases in which an active chronic ulcer was present, and is a characteristic of much value in deciding upon the relationship of a cancer to a previously-existing ulcer. Embedded in the fibrous tissue, which maintains the continuity of the wall and through which perforation will occur if it takes place, we find a number of blood-vessels. The arteries usually reveal a very marked degree of obliterative endarteritis, often amounting to practically complete closure of the vessel, and the veins show a like alteration. *Fig. 406* (*Case 22.654*. Mr. Morley) presents this extremely well; and the condition is almost always to be found in some part or other of the lesion. Sometimes a large vessel is thrombosed, as in *Fig. 407* (*Case 22.596*. Mr. Garnett Wright), which illustrates such a case, a clot obliterating the vessel and undergoing organization in its deeper parts. This arterial obstruction is sometimes very striking.

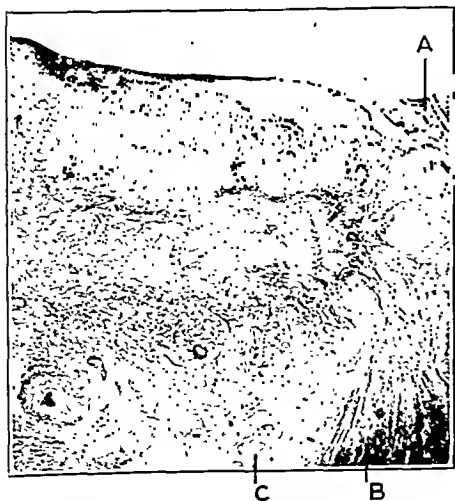


FIG. 405.—Edge of a chronic ulcer. A. Epithelium at edge; B. Muscle, terminating abruptly in the mass of fibrous tissue to the left which forms the base of the ulcer; C. Nerve trunks in the scar. ($\times 10$.)

as for example in the case illustrated by *Fig. 408* (*Case 22,784*, Mr. Garnett Wright), where an organized thrombus is seen in the main vessel of the lesser curvature at this particular point. Such obstruction must influence the



FIG. 406.—Vessels on the lesser curvature, above a chronic ulcer, showing obliterative endarteritis. The fibrous tissue of the ulcer lies below. ($\times 12$.)

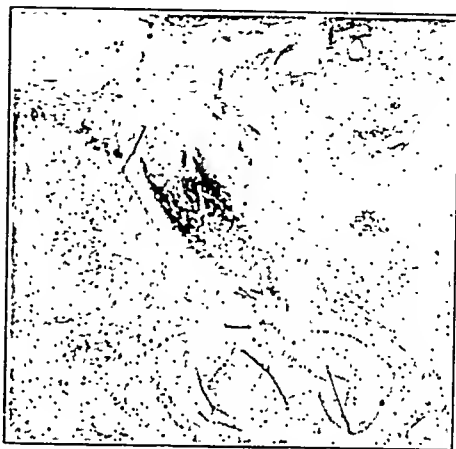


FIG. 407.—Eroded vessel, plugged by a thrombus, in the base of a chronic ulcer. ($\times 10$.)

chronicity of the lesion and militate against healing. The controlling factor in setting up obliterative endarteritis is not clear, and although a very frequent, it is not an invariable, feature of chronic ulcers. *Fig. 409* (*Case 22,756*, Mr. Jefferson) shows large patent vessels in the base of an ulcer, from a case whose history was of six years' duration, and which, should active extension occur, would be very liable to cause hæmorrhage. It may be noted that in this case there is a general deficiency of fibrous reaction and the base of the ulcer is much thinned; the patient suffered from severe and almost fatal hæmatemesis some months before operation. In this figure a lymphatic gland will also be noted, lying in the fibrous tissue of the lesser omentum close to the floor of the ulcer, and the same may be seen in other of the illustrations. It is a very constant feature to find such a 'sentinel gland' lying

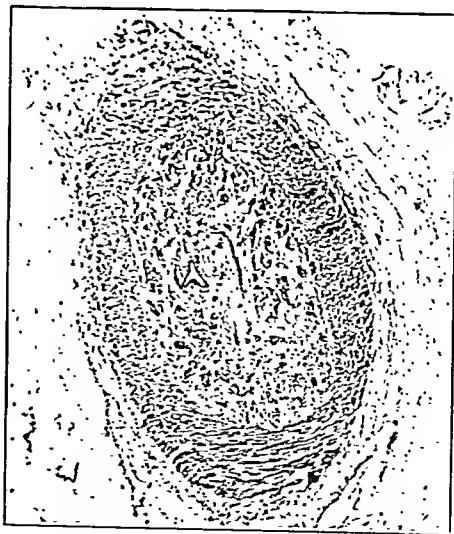


FIG. 408.—Coronary artery of stomach, occupied by an organized thrombus. ($\times 30$.)

just above the ulcer if this is of a chronic nature. It appears in many cases to be a special development from potential lymphatic cells lying in the



FIG. 409.—Thin-floored gastric ulcer, without endarteritis of adjacent vessels. Note the sentinel gland at the base of the ulcer. There is a small clot in one vessel. ($\times 10$.)



FIG. 410.—Group of sympathetic ganglion cells in the fibrous tissue of a chronic ulcer. ($\times 250$.)

omental areolar tissue. In the base of the ulcer, at some distance from the surface, it is common to see some nerve-trunks, often embedded in dense



FIG. 411.—Healed ulcer, with persisting endarteritis of lesser-curvature vessel. A, Muscle remnants; B, Fibrous tissue; C, Artery showing endarteritis. ($\times 12$.)

fibrous tissue, but generally appearing little the worse for it and retaining their perineurium intact. In other cases one may see, in the depths of the fibrous tissue of the ulcer floor, isolated or small groups of large, angular, vesicular cells (*Fig. 410, Case 22,520, Mr. Wrigley*) lying in a loose areolar network. These are persisting ganglion cells of the sympathetic plexuses, which, like the nerves, seem to resist extremely well. They may be mistaken for cancer cells.

When an ulcer heals completely, the scar and loss of continuity in the muscle persist. The endarteritis also persists in some cases, as is shown by *Fig. 411 (Case 10065, Mr. Morley)*, which illustrates a healed ulcer with a floor of scar tissue and a small, almost obliterated, artery in the lesser omentum; the sentinel gland is also seen. In some cases this endarteritis

seems to resolve, at any rate it is not always found: but it is impossible to be sure of the duration of the previous ulcer, and a scar may represent an acute and fairly quickly-healing lesion.

THE EVIDENCE OF PREVIOUS CHRONIC ULCER IN GASTRIC CANCERS.

Now, from the characters of ulcers, are there any criteria which we can adopt that will enable us to detect preceding ulcer in an existing cancer? I think there are three which call for consideration and which are of real use in arriving at a properly balanced conclusion. The mere presence of an ulcer-like crater is, of course, not of the slightest significance. These three appearances are: (1) *The presence of endarteritis obliterans* or of vessels



FIG. 412.—Fungating columnar-celled tumour of the lesser curvature.

containing organized thrombi; (2) *The existence of extensive fibrosis*; (3) *The extent of muscular destruction*. In drawing up this list the most important has been placed last.

1. With regard to endarteritis, which is so constant a feature of ulcers, the question arises: Can this be produced by carcinoma? And to this I think we must answer, Yes. Fig. 412 (Case 22, 519, Mr. Wrigley) illustrates a large, fungating, columnar-celled carcinoma of the lesser curvature, in which from other evidence, of a nature to be alluded to immediately, I do not think there is much suggestion of pre-existing chronic ulcer. The next illustration (Fig. 413) shows that in this case there is marked endarteritis of the lesser-curvature arteries, in close proximity to a lymphatic vessel distended by malignant growth. In another case, Fig. 414 (Case 10175, Mr. Garnett Wright), with only three months' history of gastric trouble, where the diagnosis

was of carcinoma and the condition found was one of ulcerating carcinoma, with the whole of the ulcerated area deeply infiltrated with tumour cells, endarteritis obliterans was found present in a vessel of the submucosa just beyond the spreading edge of the growth (*Fig. 415*), the section being taken about two inches below the lesser curvature, and the tissues around showing no suggestion of chronic ulceration. The same condition is even more strikingly illustrated in *Fig. 416* (*Case 10368*, Mr. Morley), which is a transverse section of the pyloric canal in a case of an encircling pyloric carcinoma of eight months' duration. There is no suggestion of ulcer, and the musculature of the lesser curvature is intact, whilst at the same time there is also a complete absence of scarring. Nevertheless, the smaller lesser-curvature vessels have the well-marked obliterative endarteritis seen in the figure, and shown under a high power in *Fig. 417*. The above are especially well-marked

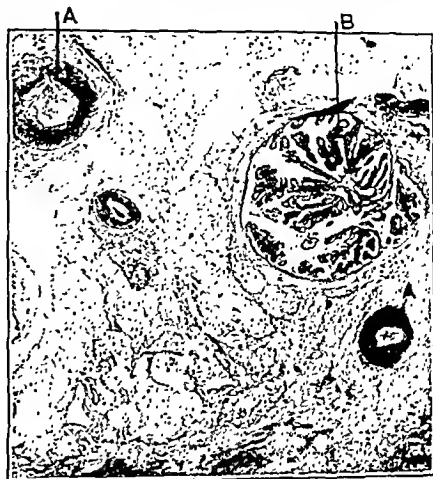


FIG. 413.—Endarteritis obliterans in relationship to gastric cancer. A, Thickened arteries; B, Lymphatic injected by tumour growth. ($\times 10$.)



FIG. 414.—Ulcerating carcinoma of lesser curvature, from behind. A, Site from which section shown in *Fig. 415* was taken.

instances, but similar changes are seen to a lesser degree in other specimens, and it must therefore be conceded that carcinoma, *per se*, may give rise to

endarteritis. That it always does so is certainly not the case, as is well exemplified by *Fig. 418* (*Case 22.238*, Mr. Hughes), four months' history, where there is no evidence of endarteritis in the lesser-curvature vessels, although they are involved in the fibrous tissue of a sclerosing carcinoma.

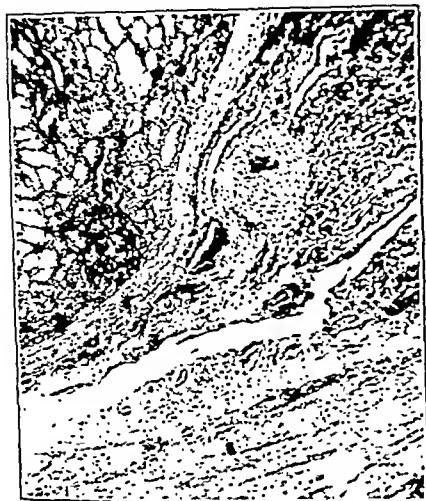


FIG. 415.—Obliterative endarteritis in relation to tumour extension. Intact epithelium is seen on the left; the tumour is infiltrating beneath the muscularis mucosae, and a vessel, in an advanced condition of obliterative endarteritis, is seen in connection with the advancing growth. ($\times 30$.)

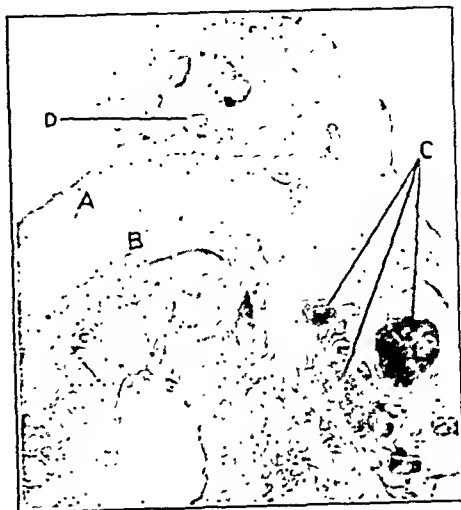


FIG. 416.—Transverse section of pyloric antrum, showing early carcinoma. A, Longitudinal muscle; B, Circular muscle; C, Masses of growth permeating the wall of the stomach; D, Vessel referred to in *Fig. 417*. ($\times 4$.)

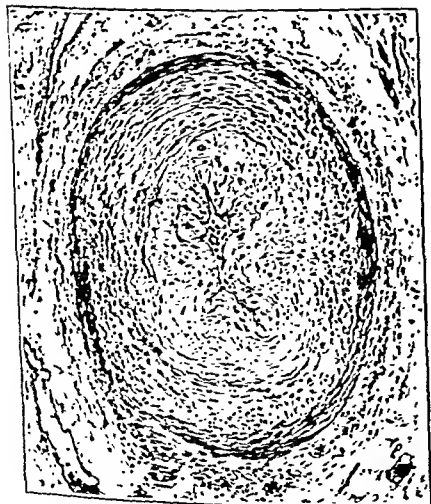


FIG. 417.—A lesser-curvature artery (D) from the previous case. Showing extensive obliterative endarteritis. ($\times 50$.)



FIG. 418.—Lesser-curvature vessels in the tissue of a scirrhous type of adenocarcinoma. There is no endarteritis obliterans in this case. ($\times 27$.)

Consequently, in interpreting this condition, more stress has been laid upon its absence, as pleading against the existence of previous ulcer, than its presence as giving positive evidence of that condition.

2. The presence of fibrosis or scarring is an even less trustworthy guide. It is constant in ulcer, but it is just as constant in the scirrhus type of carcinoma. It is pointed out by some⁷ that a carcinoma arising in a chronic ulcer would tend rather to spread into the soft tissues round about than to



FIG. 419.—Very early carcinoma of the stomach. The continuity of the muscle across the base of the growth is well seen. The tumour has penetrated the submucosa and is invading between circular muscle bundles. There is as yet practically no ulceration. ($\times 2$)

invade the sclerosed fibrous tissue proper to the ulcer. I do not know that we can entirely fall in with this suggestion as a basis for the interpretation of the distribution of malignant cells in a sclerosed lesion; but hold that it can only be agreed that fibrosis in a gastric cancer may be interpreted as evidence of ulcer when it exists entirely free from malignant cells, and that a scar infiltrated with tumour may equally well be the product of an ulcer undergoing malignant invasion, or wholly the result of a scirrhus type of tumour growth. Which it is, in the absence of other evidence, we are not able to say. In malignant disease the absence of a scar is useful evidence in negating previous ulcer, but its presence is of little value by itself in pointing to the existence of that condition.



FIG. 420.—Higher-power view of Fig. 419. A, Normal mucosa; B, Muscularis mucosae; C, Tumour invading the submucosa; D, Intact circular muscle. ($\times 12$)

3. The third consideration is the condition of the muscular wall, and it is this, perhaps, which affords the evidence of the greatest reliability. Chronic ulcer locally destroys the muscular coat *in toto*; this is true of practically every case. Cancer may or may not do this. The extent to which it does depends upon its type, duration, and rate of growth; but

where we can trace muscle as a solid band though the entire base of the tumour, there, I think, on these grounds alone, we can safely say that the



FIG. 421.—Encircling pyloric carcinoma. Muscle intact.

the evidence is wholly against there having been any preceding ulcer. And, further, if we can trace it in a more attenuated form, as separated strands running between the tumour cells, then we have evidence which will weigh heavily, when considered along with the other points previously discussed, in arriving at a conclusion as to the presence or absence of a pre-existing chronic ulcer.

The case in which complete preservation of the muscular coat nega-

tives the possibility of pre-existing ulcer may be illustrated by the following specimens. *Fig. 419* (*Case 22,599*, Dr. Ryrie) shows the condition in a very early carcinoma—the earliest I have yet seen. The tumour was an accidental finding at a post-mortem in the case of a man, age 79, dying from the results of prostatic hypertrophy and added sepsis. A small nodule, about the size of a florin, was found upon the posterior wall midway between the cardia and the pylorus. On section it proved to be an early carcinoma, just commencing to ulcerate, and confined almost entirely to the mucosa and submucosa. The same growth is shown under a higher power in *Fig. 420*, in which the integrity of the muscle and

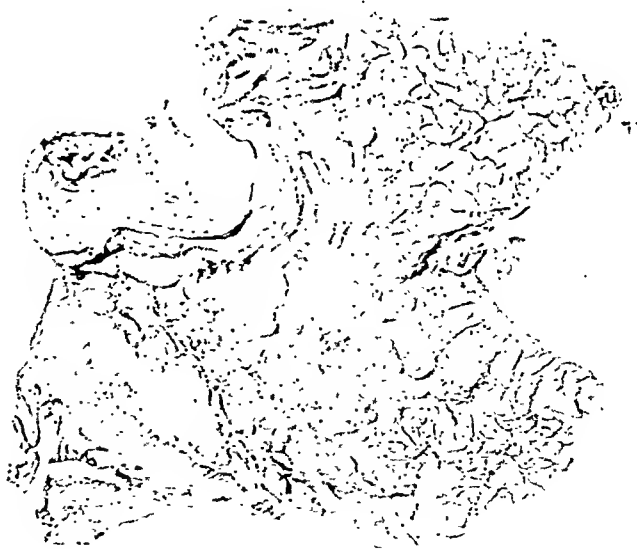


FIG. 422.—Diffuse pyloric carcinoma. Muscle intact.

absence of signs of previous chronic ulcer may be noted. The next illustration (*Fig. 421, Case 22.540, Mr. Douglas*) shows a pyloric cancer in which the integrity of the muscle is clear to the naked eye, and a third example is seen in *Fig. 422 (Case 22.747, Mr. Morley)*. The same condition has also been illustrated in *Fig. 416* in another connection.

In all the above examples there is complete muscle preservation, obvious to the naked eye and confirmed by microscopical examination. In other cases in which this form of evidence is valuable the muscle preservation is less complete; but often where to the naked eye the muscle is extensively infiltrated, microscopical examination nevertheless shows the presence of a substantial and continuous band of muscle throughout the growth in the



FIG. 423.—Ulcerating carcinoma of lesser curvature. Superficially simulating ulcer.
A, Ulcerating growth.

lesser-curvature area, and other evidence, such as complete absence of cicatricial fibrosis and of obliterative endarteritis, may go to demonstrate that there is no histological suggestion of the previous existence of a chronic ulcer. For example, *Fig. 423* shows a carcinoma from the post-mortem room (*Case 9978, J. H. D.*) with a superficial resemblance to ulcer. Here, on minute examination, the muscle preservation is found to be complete, and other evidence suggestive of ulcer is entirely lacking.

It is on grounds such as these, of which certain well-marked examples have been cited, that the conclusions arrived at in this work have been based. Up to now we have excluded from consideration certain other cases of carcinoma in which from reasons of site the question of an ulcerous origin hardly

arises. These comprise greater-curvature growths which do not involve the common ulcer-bearing region at all: a good example of such is seen in *Fig. 424* (*Case A.807. Mr. Morley*). Although it must be conceded that ulcer may occur in any position in the stomach, the coincidence of ulcer and



FIG. 424.—Carcinoma of the greater curvature, not involving the common ulcer-bearing site. The stomach wall, along the lesser curvature, is intact.

carcinoma upon the greater curvature, at a distance from the pylorus, is sufficiently improbable to allow of tumours occupying this site being considered as almost certainly 'primary', in the sense that they do not arise from chronic ulcer. A certain number of such growths occur and must be reckoned with in compiling statistics.

SUMMARY OF CASES OF GASTRIC CARCINOMA.

The gastric cancers which have come under examination in this investigation, and whose features will now be briefly summarized, have to some extent being selected, and cannot therefore be considered as examples of a consecutive series of cases. The surgeons who have contributed the material have not sent malignant stomachs to the writer for routine investigation, but, consciously and subconsciously, have admittedly contributed their doubtful cases, especially those bearing upon the question of this inquiry. It follows, therefore, that the present series contains a higher proportion of examples in which the question of cancer implanted upon ulcer arises than would a consecutive series obtained in the course of everyday practice; hence any figures which are arrived at as to the frequency of the causal association of ulcer with carcinoma will probably be somewhat higher than is actually the case when unselected carcinomata are alone considered. The following

tables briefly summarize the main characteristics of the cases of carcinoma investigated. According to the histological findings these are grouped into:

Group A: 'Primary' carcinomata. Cases in which there is no suggestion whatever of previous ulcer (*Table I*).

Group B: Cases which present certain appearances that are common to

Table I.—GROUP A. PRIMARY CARCINOMA

LABORATORY NUMBER	SURGEON	CLINICAL & OPERATIVE DIAGNOSIS	AGE AND SEX	DURATION OF GASTRIC SYMPTOMS (YEARS)	SITE	HISTOLOGIC
9577	Mr. Rayner	—	M. 30	$\frac{1}{2}$	Diffuse, whole organ	Carcinoma
9725	Mr. Morley	Carcinoma	F. 25	$\frac{1}{2}$	Greater curvature extending to lesser	Carcinoma (encephaloid)
9751	Mr. Rayner	Carcinoma	M. 54	1	Pyloric	Carcinoma
9812	Mr. Rayner	Clin.: chronic ulcer Opn.: carcinoma	F. 41	5	Encircling pyloric antrum	Carcinoma (extreme)
9819	Mr. G. Wright	Carcinoma	F. 30	$\frac{8}{12}$	Pyloric	Carcinoma (scirrhous changes)
9953	Mr. G. Wright	Carcinoma	F. 66	$\frac{1}{12}$	Pyloric	Adeno-carcinoma (scirrhous)
9978	J. H. D., P. M.	Naked-eye: carcinoma	M. 60	—	Lesser curvature	Carcinoma (scirrhous)
10319	Dr. Birkett, P. M.	Naked eye: carcinoma	M. 47	—	Pyloric	Columnar-carcinoma
10320	Mr. G. Wright	Carcinoma	M. 50	2	Greater curvature, near fundus	Adenocarcinoma (encephaloid)
10368	Mr. Morley	Carcinoma	M. 53	$\frac{8}{12}$	Pyloric	Columnar-carcinoma
10383	Mr. Ray	Carcinoma	—	—	Lesser curvature	Columnar-carcinoma (scirrhous)
22, 55	Mr. Jefferson	Carcinoma	M. 42	$\frac{1}{12}$	Lesser curvature	Columnar-carcinoma
22, 238	Mr. Hughes	Clin.: carcinoma Opn.: chronic ulcer ? malignant	M. 67	$\frac{1}{12}$	Lesser curvature	Adenocarcinoma
22, 439	Mr. Hey	Carcinoma	F. 51	7	Encircling pyloric pre-	Columnar-carcinoma (colloid)
22, 540	Mr. Douglas	Clin.: ? ulcer Opn.: carcinoma	M. 32	$\frac{5}{12}$	Ditto	Carcinoma

both carcinoma and ulcer, but in which the sum of the evidence points to these being produced by the tumour (*Table II*).

Group C: Cases in which the histological appearances cannot be distinguished from those which might result from carcinoma implanted on pre-existing ulcer.

THE NO SUGGESTION OF PREVIOUS ULCER

HISTOLOGICAL DETAILS			REMARKS
CONDITION OF MUCOUS COAT	PRESENCE OF LOCALIZED AREAS OF SCAR TISSUE	PRESENCE OF ENDARTERITIS ORBULEAN-	
Intact	Absent	Absent	Linitis plastica type of growth.
Not infiltration on lesser curvature	Absent on lesser curvature	Absent on lesser curvature	On the greater curvature, the muscle is infiltrated and destroyed and endarteritis is present in a submucosal vessel.
Intact	Absent	Absent	—
Intact	Absent	Absent	Limited linitis plastica type.
Intact	Absent	Absent	—
Excised but preserved	Absent	Present in vessels of both curvatures	—
Excised but preserved	Absent	Slight, in malignant areas only	<i>Fig. 423.</i> No endarteritis in the larger vessels of the lesser curvature.
Excised but intact	Absent	Traces	—
Intact	Absent	Absent	—
Intact	Absent	Very marked (<i>Figs. 416, 417</i>)	—
Excised and destroyed	Fibrous tissue permeated with carcinoma replacing destroyed muscle	Absent	A recurrent growth at the site of one previously excised: of interest as showing features which might have been attributed to the presence of chronic ulceration.
Excised malignant destruction	Fibrosis where tumour has destroyed muscle	Absent	—
Excised but not interrupted	Absent	Absent	—
Intact	Absent	Absent	Spread is mainly submucous.
Intact	Absent	Absent	<i>See Fig. 421.</i>

Table I.—G.

LABORATORY NUMBER	SURGEON	CLINICAL AND OPERATIVE DIAGNOSIS	AGE AND SEX	DURATION OF GASTRIC SYMPTOMS (YEARS)	SITE	HISTOLOGICAL
22,599	Dr. Rytic, P.M.	—	M. 79	—	Post. wall near lesser curvature	Columnar-carcinoma
22,704	J. H. D., P.M.	Naked eye: carcinoma	M. 42	—	Greater curvature, prepyloric	Columnar-carcinoma
22,747	Mr. Morley	Carcinoma	F. 34	10	Encircling pyloric antrum	Carcinoma
A. 807	Mr. Morley	Carcinoma	M. 55	$1\frac{1}{2}$	Greater curvature	Columnar-carcinoma

Table II.—GROUP B.* CASES PRI

9767	Mr. Morley	Carcinoma	M. 65	$\frac{6}{12}$	Pyloric	Carcinoma (scirrhus)
10029	Mr. Morley	Carcinoma	M. 55	$\frac{6}{12}$	Pyloric	Adenocarcinoma (scirrhus)
10034	Mr. G. Wright	Carcinoma	M. 53	$\frac{6}{12}$	Pyloric antrum, lesser curvature	Carcinoma (scirrhus)
10128	Mr. Hey	Carcinoma	M. 52	$\frac{6}{12}$	Lesser curvature	Adenocarcinoma (scirrhus)
10175	Mr. G. Wright	Carcinoma	M. 55	$\frac{2}{15}$	Lesser curvature	Carcinoma
22,21	Mr. Morley	Clin.: pyloric stricture Opn.: carcinoma	M. 51	$2\frac{6}{12}$	Pyloric encircling	Columnar-carcinoma
22,519	Mr. Wrigley	Carcinoma	F. 59	—	Lesser curvature, high up	Columnar-carcinoma
22,602	Mr. Jefferson	Clin.: gall-stones Opn.: Gastric ulcer with unusual features: malignant disease suspected	F. 44	—	Anterior wall near greater curvature	Carcinoma unusual type
22,727	Dr. Birkett, P.M.	Carcinoma	—	—	Lesser curvature near oesophagus	Carcinoma

* It is to be noted that in these cases a considerable degree of muscular disintegration has been found, and, in consequence and result of the malignant growth, which in the above series was usually of a scirrhus nature, (scirrhus).

PRIMARY CARCINOMATA—continued.

HISTOLOGICAL DETAILS			REMARKS
CONDITION OF MUSCULAR COAT	PRESENCE OF LOCALIZED AREA OF SCAR TISSUE	PRESENCE OF ENDOARTERITIS OR OBSTRUCTION	
Intact	Absent	Absent	<i>See Fig. 419.</i>
Lesser curvature intact	Absent	Absent	Muscle of greater curvature undergoing malignant disintegration.
Intact	Absent	Absent	<i>See Fig. 422.</i> Exploration for ulcer two years previously showed no lesion.
Destroyed by invasion on greater curvature	Fibrosis in malignant area	Absent	<i>See Fig. 424.</i>

PEARANCES COMMON TO CARCINOMA AND ULCER.

Completely replaced by massive epithelial growth	Only with advanced malignant infiltration	Absent	—
Undergoing rapid malignant destruction and immediate necrosis	Ditto	Present in scirrhus area	—
Infiltrated but incompletely destroyed	Present	Absent	There appears to be a small completely healed scar in the vicinity of the tumour but not involved in it.
Extensively infiltrated and undergoing destruction, but largely persisting	Following muscular disintegration	Present in scirrhus areas	—
Partial destruction but no interruption	Fibrosis only in malignant area	Present	A rather advanced growth. <i>See Figs. 414 and 415.</i>
Destroyed, but portions present through base of growth	Absent	Present with intact muscle, in invaded areas	—
Extensively destroyed by growth, but fibres traceable at base of tumour	Absent	Present in invaded areas	<i>See Fig. 412.</i> A rather advanced fungating growth.
Infiltrated but not interrupted	Absent	Absent	—
Interrupted only over a small area by malignant growth	Only in malignant zone	Shown, with early malignant invasion, in a few vessels	Rather advanced.

Careful examination of the whole area leads to the conclusion that these are both to be considered the same, but also in secondarily invaded glands.

Thus as a result of examining the 33 cases of carcinoma in which the lesions were sufficiently early to afford results capable of interpretation for the purpose of this inquiry, in 19 no evidence was found which was in any way suggestive of pre-existing ulceration, and in 9 the weight of the evidence was against any causal association of chronic ulcer with carcinoma.

GROUP C.

There remain five cases in which, on *histological grounds alone*, the appearances might be interpreted as indicating the supervention of malignant disease on chronic ulcer. These cases will now be briefly described.

1.—Case 9970, Mr. Morley. Male, age 33. The history was of five years' gastric pain, periodic in the earlier stages but daily for twelve months prior to operation. X-ray and clinical diagnoses were of simple ulcer, and the operative diagnosis concurred with these opinions, although the surgeon was in some doubt as to the entire innocence of the condition.⁸ The specimen removed by gastrectomy was considered by the writer to be probably malignant, although in many features suggesting simple ulcer. On section it was found to be a simplex carcinoma of a very scirrhus type, widely invading, and with complete destruction of the muscular coat over a small area and replacement there by scar tissue, which, however, was infiltrated with scattered tumour cells.

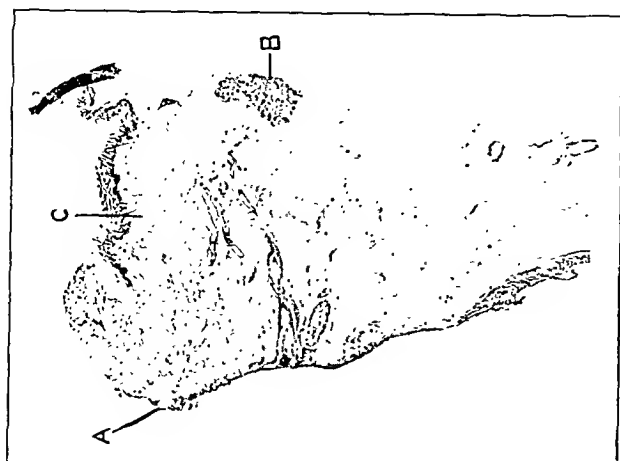


FIG. 425.—Malignant ulcer of lesser curvature. A, Area of recognizable malignant change (see Fig. 427); B, Sentinel gland (see Fig. 426); C, Duodenal mucosa. ($\times 2$.)

There was also a large amount of fibrosis, associated with scirrhus carcinoma, in the gastrohepatic omentum, and a well-developed band of fibrosis in the submucosa, also riddled with tumour cells. The features of this case were then those of a widely disseminated and extremely scirrhus form of growth, associated with ulceration and promoting a great deal of cicatricial contraction.

2.—Case 10,093, Mr. Morley. Female, age 33. History of pain after food for six months. A diagnosis of carcinoma of the pyloric region was made and gastrectomy was performed. The specimen was one of a lesser-curve growth producing annular stricture of the stomach at the pylorus; its gross anatomy closely resembled that of ulcer. Fig. 425 is a section from the lesser curvature in the coronal plane, and well exemplifies the appearances under a very low magnification. The muscular coat is completely interrupted over a distance of almost an inch, and the interval is filled by fibrous cicatricial tissue, ulcerated on the surface, in the midst of which are some large vessels containing organized thrombi. On casual inspection the section seems innocent; but closer examination reveals a small secondary nodule of epithelium in the peripheral sinus of a small 'sentinel' gland (Fig. 426) and a definitely malignant area close to the duodenal mucosa at the edge of the ulcerated zone

(Fig. 427). The malignant cells cannot be traced throughout the whole of the fibrosed area, many considerable tracts of inflammatory granulation tissue appearing devoid



FIG. 426.—Sentinel gland shown in Fig. 425. A, Small nodule of epithelium invading peripheral sinus of gland. ($\times 30$.)

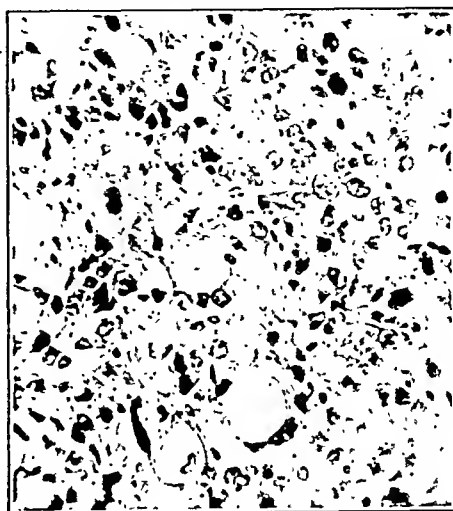


FIG. 427.—High-power view of area A, Fig. 425: a definitely malignant area at the edge of the ulcerated zone. ($\times 270$.)

of them. There is extensive involvement of the adjacent lesser-curvature glands, and in these the extreme degree of fibrous reaction occasioned by the tumour is also

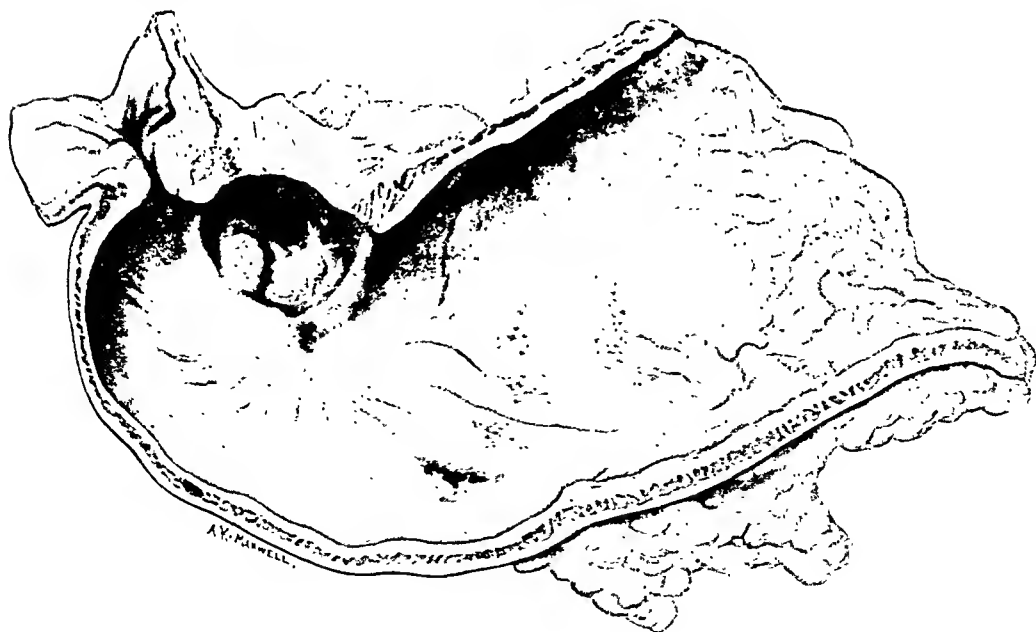


FIG. 428.—Malignant gastric ulcer. Case 10167.

very noticeable, it being impossible to detect malignant cells in some of the more advanced portions of the growth. The type of tumour is very variable, in a few areas being typically columnar-celled and in others purely simplex in character. Here again is a malignant growth, scirrhus in character, accompanied by features which seen by themselves would bear the stamp of simple ulceration.

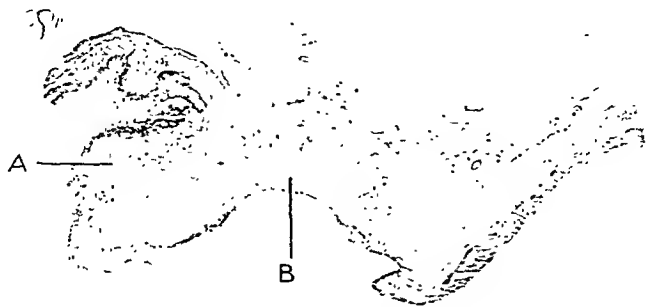


FIG. 429.—Coronal section from Fig. 428. Note the great resemblance to simple chronic ulcer. A, Duodenal mucosa; B, Fibrous scar permeated by carcinoma. ($\times 2$)

3.—*Case 10167, Mr. Burgess.* Male, age 39. History of gastric symptoms of about twenty years' duration, more severe latterly and accompanied by almost constant pain. Diagnosis prior to operation: gastric ulcer. Diagnosis at operation: chronic gastric ulcer with possible malignant change supervening. The lesion

here (Fig. 428) is that of an apparently chronic ulcer of the lesser curvature, close to the pylorus; its thickened rolled edge remotely suggested malignancy. A large section through the lesser curvature in the coronal plane is shown in Fig. 429. From this, and from the naked-eye specimen, it will be seen how closely the condition resembles the anatomical features of ulcer. The muscular coat is completely interrupted and replaced by a fibrous cicatrix, which is, however, extensively infiltrated by cancer cells where ulceration is taking place, but is more purely fibrotic in its deeper parts. The vessels show a moderate amount of endarteritis. The growth is mainly adenocarcinoma in type and is of the scirrhus variety. A small gland from the base of the lesion is invaded, the same type of scirrhus adenocarcinoma being reproduced (Fig. 430). Here the findings are those which might result from malignant change in a chronic ulcer.



FIG. 430.—Gland from the same case as Figs. 428 and 429. To show malignant invasion, and extremely scirrhus nature of the growth. ($\times 270$.)

4.—*Case 10440, Mr. Garnett Wright.* Male, age 43. History of gastric symptoms of twelve months' duration. Pre-operative diagnosis: duodenal ulcer. Diagnosis at operation: callous duodenal ulcer, suspicious of carcinoma. When the specimen, removed by gastrectomy, was opened, it appeared to be an annular carcinoma of the pylorus. Sections along the lesser curvature show the muscular coat well preserved, though undergoing penetration by the tumour, which is a

carcinoma simplex of a moderately scirrhus type. A section through the posterior wall of the pyloric canal, in the horizontal plane, shows complete interruption of the muscular coat for a very short distance and replacement by a fibrous scar (Fig. 431), which, however, is extensively infiltrated with growth. There is thrombosis and organization in one vessel of the submucosa. Sections taken from the lesser

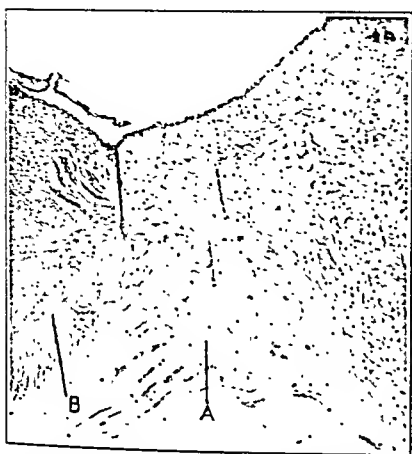


FIG. 431.—Horizontal section through the posterior wall of the pylorus, Case 10440. A. Fibrous scar containing disseminated foci of malignant cells, not evident at this magnification; B. Duodenal musculature. ($\times 10$.)



FIG. 432.—Subpyloric gland from Case 10440 (Fig. 431). To show scirrhus nature of the growth. The area seen is mainly fibrous, but malignant cells are present, especially in the lower portion. ($\times 260$.)

curvature in the coronal plane show well-preserved muscular coats undergoing destruction by tumour cells, but free from fibrous scarring, and the lesser-curvature vessels are not the seat of any endarteritis. The subpyloric glands are involved and the general scirrhus character of the growth is reproduced therein (Fig. 432). In this case the widespread evidence of growth in the ulcerated area and the distribution of the latter are such as to militate against the suggestion of pre-existing ulcer, and this case might with justice be placed in Group B (Table II).

5.—Case 22.655, Mr. Garnett Wright. Female, age 53. History of pain and vomiting after meals of four months' duration. Pre-operative diagnosis: gastric or colonic carcinoma. Diagnosis at operation: early gastric carcinoma. The specimen removed at operation shows an elongated, serpiginous, left-like ulcer on the lesser curvature with whitish, raised, infiltrated edges. Saddle-blocks taken from end to end of the lesion show the presence of an adenocarcinoma of a scirrhus type, with the mucosa intact over the greater part of the infiltrated area, and active ulceration only present in a limited zone at the proximal end. The adjacent areas show intact stomach wall with some malignant infiltration of



FIG. 433.—Saddle-block of lesser curvature, Case 22.655. The ulcer-like lesion is densely and diffusely infiltrated with cancer cells, but a band of sclerosed fibrous tissue (A), in the submucosa of the posterior wall, suggests a previously existing ulcer. ($\times 2$.)

adjacent areas show intact stomach wall with some malignant infiltration of

submucosal and subperitoneal coats. Where ulceration has occurred the muscle is destroyed and a fibrous cicatrix is present, diffusely infiltrated with carcinoma cells (*Fig. 433*). A striking feature, however, is the presence of a sclerous area of well-developed fibrous tissue in the submucosa on the posterior wall—a site very prone to be affected in the same way in simple ulcer. Over large tracts this tissue appears to be devoid of malignant cells; but it is very difficult to be certain upon this point, as these cells often become extremely atypical in areas of dense fibrosis. This case therefore presents features which may be ascribed to pre-existing simple ulceration.

CONCLUSIONS ON THE GASTRIC CARCINOMATA.

It is now time to survey the findings which have been presented in connection with this series of cases. In a total of 164 stomachs submitted to examination, 33 cancers have been met with, out of which the hypothesis of an origin in pre-existing ulcer has been immediately rejected in a group of 19. In cases, such as the majority of these, in which the tumour tends to spread in the submucosa, the other structures are left free, and an opinion is easily arrived at. Where muscle is invaded and destroyed by a growth naturally of a scirrhus type, the matter becomes one of much greater and often extreme difficulty, except in the very early stages of the process, which unfortunately are not often seen. In a second, smaller, group of 9 cases (*Group B*), this second condition has been the prevailing one, and here the hypothesis has only been rejected after a close and tedious investigation. Excluding these two groups, only 5 cases remain which have survived the scrutiny to which they have been subjected, and in these 5 it does not seem possible to say, on purely histological grounds, whether or not ulcer has preceded cancer, although in one case (No. 4) the tendency of the evidence is against such a view. It must be noted that in all these cases the carcinoma is invariably of a scirrhus type, tending naturally to produce those very alterations which have been taken as evidence of ulcer. This is particularly striking when we look at the distribution of the different types of tumour in *Groups A, B, and C*.

	GROUP A		GROUP B		GROUP C	
	Columnar-celled	Adenocarcinoma and Carcinoma Simplex	Columnar-celled	Adenocarcinoma and Carcinoma Simplex	Columnar-celled	Adenocarcinoma and Carcinoma Simplex
Number in group	8	11	2	7	0	5

That is to say, the proportion of adenocarcinoma and carcinoma simplex, which are as a rule the more sclerous of the types of cancer occurring in the stomach, rises as we proceed from the series in which there is no evidence of previous ulcer, to reach a maximum in the series in which there is evidence which may be interpreted in this way. Put somewhat differently, it may be said that it is chiefly in carcinomata of the scirrhus varieties that the question arises. We are thus forced towards the conclusion that, if we base our deductions upon histological data alone, the most that we can say of a certain small proportion of cases of gastric cancer is that appearances are

found which may point to the foundation of the growth upon a pre-existing chronic ulcer, but that we cannot, in the majority of such cases, exclude the possibility that these appearances are produced by the sclerosing character of the growth itself. Hence histological evidence fails at this point. Clinical evidence, which up to now has been purposely excluded, must, however, be taken into consideration, and may in certain cases supply sufficient additional information to decide the issue. Turning to the five cases of this sort which we have just described, we find that the duration of the gastric symptoms is given as follows: (1) *Case 9970*, five years; (2) *Case 10093*, six months; (3) *Case 10167*, twenty years; (4) *Case 10110*, twelve months; (5) *Case 22,655*, four months.

The long history, so characteristic of gastric ulcer and especially likely to be found in an ulcer which has become carcinomatous, is only present in two of these cases, so that it may be fairly concluded that it is only in these two cases—out of a total of 33 cases of gastric cancer—that the whole weight of the evidence, clinical and histological, points to a direct and causal connection between the two conditions.

These conclusions are so flatly contradictory of many that have previously been referred to that it is desirable to say a word or two in explanation of the difference between our findings and those of American workers in particular. This appears, from a perusal of many of the cases put forward by others, to turn very largely upon the interpretation of the conditions present. In many of the cases quoted by those who find signs of chronic ulcer in the highest percentages of stomach cancers, it appears from the available evidence that such ulceration is the result of malignant disease and has not preceded it. Certain it is that in many of the published illustrations which purport to show evidence of the ulcerous origin of gastric cancers the appearances portrayed appear to us to support an entirely opposite view.⁹ In many cases the naked-eye appearance of the specimen might suggest, to the not-too-critical observer, chronic ulcer undergoing malignant change, since most gastric cancers ulcerate. This hasty conclusion would, however, be quite unwarranted, and we hardly suggest such errors as a serious pitfall. The ulcerating carcinoma shown in *Fig. 434* (*Case 10383*, Mr. Howson Ray) depicts appearances of this sort. Here, however, it is definitely known that the tumour could have no immediate connection with chronic ulcer, since it is a local recurrence in the stomach wall after previous operation.

It is also clear from perusal of the literature that the opinion that ulcer



FIG. 434.—Malignant recurrence in the stomach wall, ulcerating.

has preceded malignant disease is frequently adhered to on histological grounds in the face of clinical evidence pointing in the opposite direction, a practice which, with Nielsen,¹⁰ we consider hardly admissible. It cannot be sufficiently emphasized that in so difficult a problem as this every scrap of available evidence needs to be reviewed before a final decision is made.

CERTAIN OTHER CONSIDERATIONS.

The conclusion of this inquiry is that gastric ulcers, coming to operation as such, prove on removal to be simple in nature almost invariably, and that gastric carcinomata, as far as can be judged by histological evidence, are in a large majority of cases malignant from their inception. This is not a denial of the possibility of malignant change supervening in a chronic gastric ulcer; it is a conservative view of the frequency of this event. Experimental work in a variety of fields has clearly shown the tendency for a supervention of malignant disease in sites of constant irritation of a certain grade. Malignancy may supervene in a chronic ulcer of any type, but apart from the continued applications of certain known irritants it is not a common event. It may even be conceded that a gastric ulcer, by virtue of its chronicity and constant exposure to the gastric juice, is more likely to be prone to malignant change than a simple ulcer in another situation. This is conceded, but it does not affect the conclusion that this change is not a common one. It may and does take place; but it is not the normal fate of a gastric ulcer to become malignant; neither is it usual for a gastric cancer to originate in a chronic ulcer.

In the present paper the matter has been treated purely as a histological inquiry, since it is upon histological grounds that the statements we have found it necessary to combat have been based, and such supplementary evidence as is afforded by other data has been omitted from consideration. This may now be briefly surveyed, and it will be found that its weight goes almost wholly to support the view we have just defined. The nature of this additional evidence is as follows:—

1. **Site.**—Gastric ulcers are most common upon the lesser curvature at about 2 to 3 inches from the pyloric ring. Stewart (*loc. cit.*), has investigated the matter very fully and gives the following distribution: Lesser-curvature region, 73 per cent; pyloric ring, 4 per cent; prepyloric inch, 13.5 per cent; rest of anterior wall, 2.5 per cent; rest of posterior wall, 7 per cent. Gastric carcinomata occur most frequently closer to the pylorus. They may occur in the ulcer site; but this is not their commonest position, as it should be if those who support the contention of a frequent malignant change in chronic ulcer are correct. If this contention is still to be maintained, it must be modified to concede a special liability to malignant change in ulcers close to the pylorus. In this connection there may also be recalled the often-quoted fact of the immunity of the duodenum, where ulcer is common, to carcinoma.

2. **Duration.**—The history of gastric ulcer is long; that of carcinoma is short. This diagnostic fact, so much emphasized by past generations, e.g., Brinton, Osler, etc., seems almost ignored by some of the modern school. There are certain figures in our series which bear upon this point. The

average length of the history in the 108 cases of chronic ulcer, proved histologically, in which this information was available, was ten years and four months, whereas the average length of history in the 28 similarly proved cases of carcinoma was only two years and three months. This last figure is unduly high on account of the presence of a single case giving a history of twenty years' duration, which disproportionately affects a small series such as this. The distribution of the cases, for different durations of clinical symptoms, is shown in the following table :

LENGTH OF HISTORY.

CONDITION	1 YEAR AND UNDER	1-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	OVER TWENTY	TOTAL
Gastric ulcer	6	30	28	16	18	10	108
Gastric carcinoma	21	2	4	0	1	0	28

It is thus seen that whilst a long history is the rule in gastric ulcer, its absence is the rule in gastric cancer, but that there are occasional exceptions to this generalization. Although the length of the history is probably the most valuable single symptom in the differential diagnosis between the two conditions, there are undeniably certain cases of cancer in which the history is of a long duration. The five cases in this series in which a history of gastric symptoms has been present for more than three years are :—

CASE NUMBER	GROUP	LENGTH OF HISTORY
9812	A	5 years
9970	C	5 "
10167	C	20 "
22.439	A	7 "
22.747	A	10 "

Two of these are furnished by the combination of ulcer and carcinoma ; but there are others, viz., *Cases* 9812, 22.439, and 22.747, in which there is no histological suggestion of such an association.

It is very questionable if these long histories can represent the duration of the actual malignant condition, and their explanation is a matter for conjecture. A particularly good example of an instance of this kind is furnished by *Case* 22.747, *Group A*, in which the stomach was explored after eight years of gastric symptoms in the expectation of finding an ulcer. No lesion of any kind was found at that time, but the same patient was again operated upon two years later and an extensive gastric carcinoma was discovered and removed. Death took place from recurrence, six months later. It is well known how potent a factor chronic irritation is in the genesis of carcinoma, and it may be that in these cases, where there is a long history of dyspepsia but in which no evidence of ulcer is discoverable, an

obscure chronic gastric irritation, insufficient to cause gross breach of the mucosa, is an active factor in their production.

3. Age Distribution.—The average age of our cases of ulcer and carcinoma at the time of operation is 44 and 49 respectively. When the duration of the symptoms in the two conditions is taken into account, the average ages of onset are found to be more widely separated, being 33 and 45 respectively.

The incidence of the two conditions in the various age-groups in our cases is as follows :—

CHRONIC SIMPLE ULCERS (105).

	AGES 10-20	21-30	31-40	41-50	51-60	61-70	71-80
Cases in each decade ..	14	31	35	19	6	0	0

GASTRIC CANCERS (28).

Cases in each decade ..	1	5	3	6	9	3	1
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4. Statistical Information.—However informative histological and clinical evidence may be, the final appeal as to the definiteness and degree of association between the two conditions must be statistical. If the requisite figures were available, and we could know and compare the incidence of carcinoma in those who have ulcer with the incidence of carcinoma in those who have not—or, what would be practically the same thing, in the general population—then we should know what the association is and have an exact measure of its degree. No such figures being available, it is nevertheless distinctly helpful to ask what is the after-history of surgically observed cases of chronic gastric ulcer in which the ulcer is not removed. How many of these develop carcinoma? For many years the most popular operative procedure in such cases was gastro-enterostomy, and it is interesting to inquire what percentage of the persons subjected to this operation for the relief of gastric ulcer subsequently developed carcinoma. Obviously not a large number, since as late as 1914 surgeons of high repute were writing that “gastrojejunostomy alone is curative in the majority of cases”.¹¹ The matter has, however, been exactly investigated by Balfour,¹² who has published two most valuable papers on the expectation of life in persons operated upon for gastric ulcer, from figures compiled from the records of the Mayo Clinic under the aegis of the Actuarial Society of America; his accuracy for statistical purposes is therefore not likely to be called in question. The chief fact which emerged from the investigation of 2323 cases which were operated upon between 1906 and 1915, and observed over an average period of 3.6 years, was that the expectation of life in a person who had undergone an operation for gastric ulcer was, for the first five years following operation, several times worse than that of a normal person or a person who had been operated upon for the closely allied condition of duodenal ulcer, other things being equal.

Actually about 17 per cent of the cases which had recovered from operation died within this period of 3-6 years. There was, therefore, some factor present in a number of these gastric ulcer cases which prejudiced their lives. In a subsequent investigation to ascertain the nature of this,¹³ 1280 patients were followed up, and in a period of fifteen years 195 deaths after recovery from operation were found. The cause of death in the majority of these was ascertained, and 75 were found to have died from cancer. Dr. Balfour concluded therefore that "the most important single factor influencing the life expectancy of patients operated on for gastric ulcer is gastric cancer". Surveying the published statistics of operations at the Mayo Clinic, we find that over the greater portion of the period covered by these investigations excision of the ulcer was practised in only about a third of the total cases operated upon,¹⁴ so that in the majority the lesion was left *in situ*. It is therefore evident that the diagnosis of 'gastric ulcer' was usually unsubstantiated by pathological examination, and that a certain number of these cases may have been carcinomatous *ab initio*. Dr. Balfour himself states that in many of the cases in which the lesion was not removed malignancy was suspected at operation, and that it would have been more proper to classify them as gastric cancers than as ulcers. When examples of this kind are excluded from his figures, he finally concludes that the death-rate in operated cases of gastric ulcer is only something under twice that of the normal population of similar age and sex groups.

Even if we take an extreme position and include all these suspicious and unexamined cases in the category of gastric ulcers, the total death-rate from carcinoma in the series detailed in this paper is still under 6 per cent of the total number of cases operated upon. This is a very different figure from the 50 to 70 per cent who should have succumbed in the absence of radical operation were the contention correct of those who maintain that this percentage of chronic ulcers show early malignant changes. The deductions, therefore, which may be arrived at from these very instructive and important observations go to substantiate the conclusions which we have already put forward in the other parts of this paper.

The writer wishes again to express his indebtedness to those who have contributed their material towards this research, as well as to the Manchester Pathological Society and the members of the special sub-committee for the assistance they have afforded him, and especially to Mr. John Morley and Mr. Garnett Wright, who have, moreover, defrayed the cost of the examination of a considerable number of their specimens.

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THE SURGICAL TREATMENT OF CARDIOSPASM.

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GENERAL CONSIDERATIONS.

THE most unsatisfactory chapter in the surgery of to-day is that of the treatment of œsophageal obstruction. The grave discomfort of being unable to swallow, the frequency with which the obstruction is due to carcinoma, the inaccessibility of the œsophagus, and the consequent unsatisfactory results of surgical treatment, make this the most dreaded of all diseases. Fortunately there is quite a definite proportion of cases where the obstruction is not due to carcinoma and can be completely cured if recognized. Since, however, these cases also are fatal if overlooked, it becomes of extreme importance to recognize and to treat them as early as possible.

The most important of these non-malignant obstructions is that curious condition most often described as cardiospasm. It has also been known as idiopathic dilatation of the œsophagus, achalasia of the cardia, hiatal œsophagismus, and œsophagectasia. This lesion, which appears to have been first described by Ziemssen and Zenker in 1874, has excited much interest since attention was more fully directed to it by Mikulicz in 1881. In the many accounts, often of few or isolated cases, which have since followed there is no doubt that a considerable number of different lesions have been described.

It is thus essential that some clear definition of the condition should be given; all the cases would be included under the following: "A condition of dilatation and hypertrophy of the œsophagus where, on post-mortem examination, no obstruction can be found distal to the dilatation." This will exclude all cases of hysterical spasm in young men and women: these do not show any hypertrophy and dilatation, and yet it is evident from the literature that they are often confused with cardiospasm, which is a disease more commonly of middle or advanced age.

The hypertrophy and dilatation which is not infrequently seen with carcinoma or other obstruction of the lower end of the œsophagus clearly does not come into this category, but it is not so generally realized that obstruction at the pylorus may also be associated with dilatation of the œsophagus. Cases have, for instance, been reported by Ehlers¹⁰ where there was enormous hypertrophy of the œsophagus with congenital pyloric obstruction, and by Pritchard and Hillier¹⁷ where there was a similar pyloric lesion and also constriction at the ilco-cæcal valve. It is very possible that in both these cases the œsophageal lesion was secondary to the pyloric obstruction, for Hutchison²⁷ demonstrated that with congenital pyloric stenosis the hypertrophy and dilatation not uncommonly extended to the œsophagus. This is clearly shown by an investigation of post-mortem specimens. The records of the London Hospital post-mortems have been carefully investigated for me by Mr. Hamilton Bailey,

who found that six of the cases of congenital pyloric stenosis showed marked dilatation and hypertrophy of the lower half or third of the œsophagus. Mutch⁴⁰ has stated that in one-tenth of all the cases there is coincident disease of a gross nature, such as carcinoma or chronic ulceration, in the stomach. This is clearly due to a confusion of several different conditions; with true cardiospasm there is never any demonstrable lesion in the stomach, but with a large growth in the body of the stomach or at the pylorus there may be secondary dilatation similar to that found with congenital pyloric stenosis. In the London Hospital post-mortem statistics there is a large number of such cases. The same is also true with stenosing ulcers of the pylorus. Occasionally symptoms of œsophageal obstruction are found with pyloric lesions where the obstruction is apparently due to spasm. Barton and Dent¹ have described such a case where the X rays showed a check at the cardia. At operation a pyloric ulcer was alone found, and gastro-enterostomy led to a complete cure of the œsophageal condition. In such cases the characteristic hypertrophy and dilatation of the œsophagus is absent.

The true condition is characterized by a greatly dilated and hypertrophied œsophagus with no evident post-mortem obstruction. The pathological changes as seen in the advanced stages (which are those generally found after death) are well shown in the series of illustrations of cases reported by Moore.³⁸ In these and other reported cases the lumen of the œsophagus commences to be increased just beyond its origin at the cricoid cartilage. From here downwards the dilatation, as a rule, steadily increases until a point midway between the cricoid and diaphragm is reached. The extent, and even the distribution of the dilatation, is variable, and is probably always associated with lengthening of the œsophagus. Brown Kelly⁶ states that lengthening is always present. It is important to remember this fact, for during the passage of a bougie it may be thought that the instrument has entered the stomach when it is still within the elongated œsophagus.

Owing to varying combinations of the lengthening and dilatation, different varieties are described. Mikulicz laid special stress upon a flask- or pear-like form of dilatation in which the lower third or two-thirds of the œsophagus was chiefly at fault, and might show so much dilatation that it was even capable of holding two pints. In this case the narrower end is always upwards and the dilated portion bulges over the upper surface of the diaphragm. The opening through the diaphragm is always somewhat raised, the dilated portion forming a kind of sulcus around it. Such a variety is well shown in figure 8 of Moore's series (*Fig. 435*—this illustration, together with *Figs. 436 and 437*, are reproduced from Dr. Irwin Moore's series by his kind permission). With such a flask-like form the greatest dilatation is usually reached, and the circumference of the most dilated portion may be anything up to $6\frac{1}{2}$ in. or more.

Lambert³⁰ has shown that there may be three distinct varieties, the *fusiform*, which is the most common, in which there is little if any increase in the length of the œsophagus. The cardia is here the most dependent portion, the lumen steadily increasing from above downwards until a point is reached about midway between the cricoid and the diaphragm, beyond which it gradually diminishes again. Shattock⁵⁰ has also found that this is the commonest variety, and states that all examples of this type show a remarkable similarity,

although the extent of the dilatation may vary considerably. In an advanced case the circumference at the widest area may be $5\frac{1}{2}$ in. or more. A good

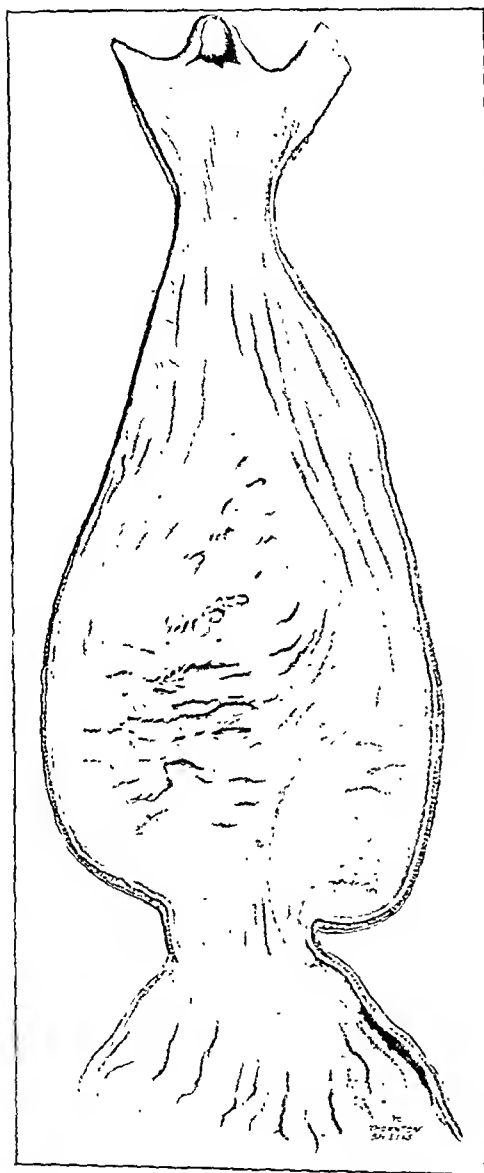


FIG. 433.—Flask-shaped variety of dilated œsophagus.

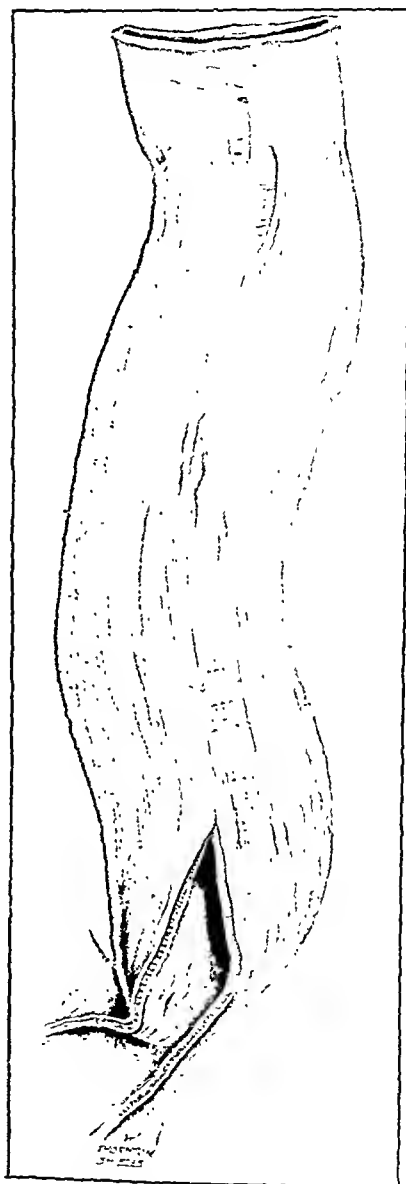


FIG. 436.—Fusiform variety of dilated œsophagus.

(By kind permission of Dr. Irvin Moore.)

specimen of this variety is shown in figure 6 of Moore's series (*Fig. 436*). Lambert's second variety is the *flask-shaped* type of Mikulicz; but he states

that the cardia is the lowest and most dependent part of the œsophagus. His third variety he describes as the *S-shaped* type. This is the rarest, and is

chiefly characterized by an increase in length, and as the cardia and the upper end are fixed, the œsophagus will bend until it becomes S-shaped. Usually the lower curve is to the right and the dilated œsophagus rests on the right diaphragm and posterior to the cardia. From this position it passes upwards, forwards, and to the left to penetrate the diaphragm. Owing to this curve a reservoir or dead space is formed below the level of the cardia. *Case 8* in my series showed this change in a marked degree, and *Cases 11 and 16* to a lesser degree (see *Fig. 451*). Although in extreme cases these three different varieties can be recognized, yet every intermediate stage may be seen. Hill²⁴ has laid stress upon the fact that in the earlier degrees the dilatation is usually spindle-shaped, but lobulations may develop later, especially near the phrenic level.

Of very considerable interest is the method of termination of the dilatation in its lowest part. In all the earlier descriptions the dilatation was stated to extend to the cardiac orifice, and a sphincter situated at the orifice was thought to be the factor at fault. Hence the condition was called cardiospasm, Gottstein¹⁸ describing it as a spastic contraction of the cardiac orifice. Chevalier Jackson first showed that the obstruction was not at the cardiac orifice but at the level of the diaphragm, and



FIG. 437.—Cardiospasm: dilatation extending to cardia.

(By kind permission of Dr. Irwin Moore.)

therefore he substituted the name phrenicospasm for cardiospasm. Hill²⁵ strongly supported this view, for he was unable to find any evidence of

spasm at the cardia; in fact he found that the circular fibre musculature at the entire lower end of the œsophagus was as weak as, or if anything weaker than, elsewhere. Brown Kelly⁷ could also find no definite sphincter, but he thought the muscle was no weaker in this position. In the 14 specimens shown by Moore, Nos. 1, 8, and 10 (*Fig. 437*) showed the dilatation reaching right down to the cardiac orifice, whilst in the remainder it ceased at the level of the diaphragm and there was a portion of undilated tube below the level of this structure. In the majority of X-ray studies which have been published this cessation at the level of the diaphragm has been a definite factor, and this is also clearly seen to be the case in the X-ray prints of most of my own cases. In the discussion of his pathological exhibits Moore showed two specimens prepared by Shattock to demonstrate the normal sphincter. These specimens make it evident that there is a relatively widespread thickening of the circular muscle extending on to both the stomach and the œsophagus which is definite enough to be called a sphincter, but is of sufficient length to give rise to a cardiac canal rather than a cardiac orifice. It is, however, situated wholly beneath the level of the diaphragm. Shattock, at this same discussion, suggested that in the early stages the dilatation only extends down to the diaphragm, but later the increasing pressure overcomes the extrinsic support of the diaphragm, and thus the dilatation passes right down to the cardiac orifice. It would, however, seem doubtful if this can be the whole explanation, for in most of my cases which were advanced and of long standing the dilatation ended abruptly at the level of the diaphragm.

Above, the extent of the dilatation is variable. In many reported cases the change has been limited to the thoracic œsophagus, while in others it extends well up into the neck. In nearly all my own cases the dilatation was very evident through the œsophagoscope as soon as the instrument was passed beyond the cricoid cartilage. Hill states that in some advanced cases the lower pharynx may be much enlarged.

The most characteristic change after the enormous dilatation is the hypertrophy of the muscular wall. All cases that have been investigated show this change. The hypertrophy is distributed over the dilated area, but is commensurate with the dilatation. The more marked the dilatation the greater the hypertrophy. Hence the level of the greatest hypertrophy will vary with the different types of dilatation. Practically in none of the reported cases has there ever been any atrophy, a very important point, for this is strongly against the view that the condition is paralytic in origin. In some cases the hypertrophy is the dominant factor, and Brown Kelly mentions a case reported by Ellison¹³ where the wall of the lower two-thirds of the œsophagus was 6 to 7 mm. thick and the viscus was converted into a rigid canal somewhat larger than a lead pencil. Ellieson¹² and Ehlers,¹⁰ on the other hand, believe that dilatation is always present in true cases of cardiospasm.

As with the dilatation, the hypertrophy of the muscular coat usually ceases below the level of the diaphragm. The portion of œsophagus passing through the diaphragm is of normal size, as is also that inch or more which lies between the diaphragm and the opening into the stomach. The stomach, including the cardiac sphincter, is as a rule normal. Hill²⁵ was unable to find

any thickening in the lower portion; in fact he states that the circular fibre musculature at the lower end of the œsophagus is as weak as, or if anything weaker than, elsewhere. In those cases described above, where the dilatation extends below the diaphragm to the cardiac orifice, there will be a corresponding extension of the muscular hypertrophy. As a general rule there is no trace whatever of any hypertrophy of the cardiac sphincter. Usually a post-mortem specimen will show no evidence of any narrowing or obstruction, and if an attempt is made to fill the dilated œsophagus with water, this will be found to be impossible, for the fluid will at once run away through the unnarrowed orifice. Naked-eye and microscopic investigation of the wall in the area of the cardiac orifice will also show no hypertrophy as a rule. All overgrowth of the muscular walls is limited to that portion of the œsophagus above the obstruction. Occasionally a case is seen in which the cardiac sphincter presents a very definite hypertrophy. In Moore's series there were two cases showing such an overgrowth, and the case reported by Brown Kelly⁸ was of a similar nature. Shattoek, in commenting on this latter case, lays stress upon its rarity. He regards the condition as similar to congenital hypertrophy of the pylorus and would not include it with the usual varieties of cardiospasm. It is of interest to note that such cases showing hypertrophy will usually hold water after death, as will the stomachs with congenital pyloric stenosis, so that the condition is not one of pure spasm.

The thickening of the hypertrophied and dilated sections is, as to be expected, due almost wholly to an overgrowth of the circular muscle-fibres.

The mucosa generally shows some secondary changes. The whole surface has been stretched, and thus the mucosa is flattened and smooth. Later, owing to the stagnation and decomposition changes that occur in the retained fluid, the mucosa becomes infected and ulcerates. Thus, in long-standing cases there are extensive areas of loss of tissue, but as a rule this is limited entirely to the mucous coat, so that perforation of the œsophagus seems to be a very rare complication, and secondary fibrosis with constriction and distortion of the œsophagus does not seem to occur. In spite of the constant irritation, which in many cases has existed over many years, carcinoma appears to be rare, although Gottstein¹⁸ states that unless cured by treatment this complication frequently develops. Of his 33 cases, carcinoma developed in three.

ETIOLOGY AND SYMPTOMATOLOGY.

It is important to emphasize the fact that cardiospasm is not a disease of young females, for it has often been confused with the hysterical affection which may occur in this type of patient. In fact many of my cases have been told that their symptoms were functional, and treatment by auto-suggestion and the like has been advocated, with, of course, only loss of time. Of my own series of 16 cases, only 6 were females, and only 2 of them were under the age of 40. The average age at which surgical treatment was sought was 52½. Symptoms in several of the cases had been present for many years, and had always been progressive since their onset, whereas the functional conditions of young hysterical women tend to disappear as the patient grows older, and are not associated with any definite organic change in the

œsophagus. Although my own series shows the majority of patients to be over middle age, there are several reported in early infancy. Tilley⁵¹ states that Chevalier Jackson has reported a case occurring in an infant two days old. Langmead³² reports another interesting case where the symptoms commenced immediately after birth. Slow progress was made, and at about the age of 18 months the child was admitted to hospital, where the diagnosis was confirmed by X-ray and œsophagoscopic examinations. She was removed from hospital before treatment could be carried out, and the later progress was not known. Parkes Weber,⁴² in the discussion following Langmead's paper, mentions the case reported by Morgan,³⁹ who had collected 5 other cases from the literature, all occurring in children under the age of 2 years. Parkes Weber⁴² was able to find 2 other cases reported in the literature by Goppert in 1908, and another by La Rozière in 1914. He had also seen a case in his own practice in a child of 5 years. These all appear to be true cases of cardiospasm, and not of the dilatation which occurs with congenital pyloric stenosis, which has already been described. Cases in which symptoms have commenced at or about the age of 20 are relatively common, and many of these have already shown the characteristic extensive dilatation and hypertrophy. Two of my own cases were only 31 years of age: one of them had had symptoms for three and the other for as long as ten years. Cases commencing at the age of 20 or so have been reported by French,¹⁷ Hurst,²² Wakley,⁵⁵ and Batty Shaw,² among many others. On the other hand, the symptoms may not become evident until old age. The oldest patient in my series was 73, but his history was short and the dilatation was but slight. The two oldest showing the definite changes, which had been present for two and four years respectively, were 65 and 66 years of age.

The frequency of true cases of cardiospasm as compared with other varieties of œsophageal obstruction is somewhat difficult to estimate. My own clinical experience includes 16 such cases occurring in a period of 11 years. During this same period I have had to treat 65 cases of carcinoma of the œsophagus, 1 of fibrous stenosis, and 3 of œsophageal pouch. This gives a percentage of 17·8, which is probably unusually high, for in the experience of most surgeons the lesion has been uncommon. As regards its frequency in general post-mortems, Mr. Bailey found 7 which could probably be included as true cases at the London Hospital for the years 1908-1915 inclusive, during which period there were in all 8332 post-mortems.

The symptoms are somewhat variable in their method of onset. Gottstein¹⁸ has described an acute variety of sudden onset lasting for some minutes, hours, or even days, and then clearing up entirely. These he regards as spasmodic in character, for even the smallest particles of food may be rejected as soon as taken. Since, however, this variety is not associated with any dilatation or hypertrophy it would seem better not to include them with cases of cardiospasm. They may be but mild varieties of the same condition, but it is quite possible that they are of an entirely different pathology. In the true cases there is as a general rule a long history. In one of my own there had been some pain, and occasional vomiting, even in childhood. In Case 6 of Moore's series there was also a history dating back to childhood. Shaw and Woo,² on the other hand, lay special stress upon the

fact that in their series of five cases all symptoms were absent in childhood. In the majority this is certainly true, although—as will be shown later—it does not of necessity mean that at this period the œsophagus was normal. In the majority there is a long history dating back for several years, but in others, although the X rays and œsophagoscope may show a very advanced change, the symptoms may extend back for only a relatively short time. In two of my cases, the pathological change was advanced, but symptoms had been noticed for only one year. Most often the commencement is gradual, but sometimes the patient can remember the exact time or day of onset. In one of my patients the symptoms followed an attack of pneumonia, being first noticed the day after he left hospital. In another the symptoms had followed bathing in the sea one cold day. Erdmann¹⁴ has specially laid stress upon this method of onset, and has in fact found that as a general rule the onset is abrupt.

In my own series it has been very noticeable that with the more insidious cases there were two distinct groups. In the one the chief symptom was pain even at the onset, and for this reason the condition was very prone to be mistaken for a gastric lesion. In the other variety the chief symptom was vomiting or regurgitation of food, and thus the true nature of the condition was less likely to be overlooked. In the first group the pain was intermittent to begin with; there were attacks lasting perhaps for a day or two, with intervals of some days or weeks of complete freedom. The pain was severe, was situated in the epigastrium, and sometimes passed through to the back. If care is taken in interrogating the patient, the fact may be elicited that in the earlier stages the pain would come on after one or several mouthfuls of food, and it is only in the later stages, when the œsophagus has become very dilated and capacious, that the pain would appear some time after the meal was finished. It is this point which will often help to distinguish this group from a gastric lesion. As the condition progresses, not only does the pain occur later, but the periodicity disappears, until severe pain is felt after every meal. Sooner or later vomiting will be added and will give a considerable amount of relief to the pain. The symptoms then become characteristic of a well-developed case, but the pain usually remains the dominant symptom.

In the other variety pain is but little marked. The patient states that he has had vomiting or regurgitation, and will have noticed that the food seems to stick. At first this is intermittent, an occasional mouthful will fail to pass, is regurgitated, and relief follows; or it may be that the food will seem to stick and a draught of fluid will bring relief. On other occasions—and in my experience this is the more frequent—the patient will notice the difficulty chiefly in drinking fluids. A long draught may be taken, the patient has a sudden feeling of discomfort, and the fluid fails to pass. It may be distinctly felt to pass after a minute or two, when complete relief is gained, or it may remain for a long time in the œsophagus with a feeling of discomfort. Gradually this discomfort may disappear as the fluid passes, or relief may be obtained by vomiting. As with the cases in which pain is the chief symptom, the obstruction is at first intermittent—an important point of distinction from an obstruction due to an organic stenosis. As the disease progresses, the symptoms will become more continuous, until difficulty is felt

at every meal; but it is soon noticed—often, indeed, after only a few weeks or months—that a large quantity, or perhaps the whole meal, is taken before there is any regurgitation. The rapidity with which this change takes place leads one to believe that the dilatation must have been present to a certain degree at least before the symptoms became evident. The rapid change is also of practical importance, for if the early history is overlooked, the fact that vomiting only takes place after the meal is finished would seem to indicate that the regurgitated material came from the stomach and that the condition was one of pyloric obstruction. One of my cases had indeed been operated upon elsewhere for pyloric carcinoma. Even if the vomiting occurs before the meal is finished, it will usually be noticed that it takes place with great facility and is unassociated with nausea and retching. Soon after the act is over, the patient, being relieved of his discomfort, can and does return to his meal with his appetite unaltered.

When the condition is well-established the patient will complain of a feeling of discomfort and fullness after each meal, which may often amount to severe pain. This is more likely to be the case in those patients whose symptoms started with pain. As the œsophagus becomes more dilated there is a greater tolerance, but this is due rather to the quantity which the œsophagus will hold before the symptoms are induced than to any lessening of the symptoms themselves. Mutch⁴⁰ has stated that in all cases three stages can be recognized. In the first there is intermittent discomfort rarely amounting to pain; in the second there is precipitate vomiting during or after a meal, which is generally speaking intermittent; and in the third there is dilatation of the œsophagus with greater tolerance. This has not been my experience. In some cases there is from the beginning very severe pain which is gastric in character so that the disease is likely to be mistaken for a gastric ulcer or carcinoma. In others the vomiting is the dominant factor and there may be little or no pain from the commencement. The discomfort that occurs in the later stages of these cases is due to distention of the œsophagus, and is sometimes associated with considerable dyspnoea, often amounting to a feeling of stifling. Vomiting then occurs spontaneously or may be induced by taking a deep breath, by voluntary retching, or even by tickling the fauces. A large quantity of fluid is then brought up, and not infrequently it may be noticed that this is greater in quantity than the fluid and food which had been taken at the meal. This may be due to retention from the last meal or to the collection of saliva. Sometimes vomiting will occur during a period of fasting; it is then almost certainly due to swallowed saliva, for frequently the disease is associated with increased salivation. Not infrequently the vomiting is more marked when the patient lies down, and Hurst states that some of his cases have been awakened at night owing to the regurgitation of the returned fluid through the nose.

The material which is returned is nearly always frothy in appearance and contains much mucus. It may consist of the fluid and food which have been taken, and is very little altered, showing none of the digestive changes which appear in gastric contents, and not having the noxious taste and odour found with this material. In the late stages material that has been taken at the previous meal, or even several meals before, may be recognized in the vomit. It

is important to realize that the contents are alkaline, or rather show an absence of free HCl, for on this finding a diagnosis of carcinoma of the pylorus has not infrequently been made, the fact that the œsophagus could contain a whole meal being unrealized. Gottstein,¹⁸ however, points out that occasionally the material drawn from the œsophagus in the early morning may be acid in reaction owing to the changes of decomposition. An important point which may help in the differential diagnosis is that the test meal or normal content commences to be returned through the tube after the latter has been passed only a short way and has certainly not yet entered the stomach.

Because so little of the food passes on to the stomach the patient rapidly wastes, and may soon reach an extreme degree of emaciation, thereby making an incorrect diagnosis of carcinoma of the pylorus or the œsophagus yet more likely. The first error should not arise, for if the history is carefully taken it will be found to be much longer, and the early symptoms will clearly be distinct from those of a gastric lesion. When well established the disease should not be mistaken for carcinoma of the œsophagus, for in this latter condition the

amount of dilatation of the œsophagus is always slight, so that even in its late stages there will be difficulty in swallowing each mouthful, and the whole meal will never be retained in the dilated œsophagus above the obstruction. In the earlier stages in more elderly people the diagnosis, as Zaaiger⁵⁰ has pointed out, is much more difficult. When once a lesion of the œsophagus is suspected the diagnosis of cardiospasm will be made certain by X-ray investigation and examination with the œsophagoscope.

With the X rays an absolutely characteristic picture is seen. When the opaque meal is being swallowed it will seem to spread out in a greatly dilated chamber and, as Jordan²⁰ pointed out, will at first appear to float in a collection of fluid, as indeed it does. As the meal sinks it will be seen to occupy an œsophagus which is dilated to an extreme degree. The actual picture presented will vary according to the pathological variety which is present, but in all cases the dilatation will clearly extend down to the



FIG. 438.—Dilatation of the œsophagus resembling cardiospasm, but due to a mediastinal sarcoma. The obstruction is, however, well above the level of the diaphragm.

level of the diaphragm. In my experience the only other condition which may give rise to a degree of dilatation in any way comparable with that of cardiospasm is an obstruction due to pressure from a mediastinal tumour (Fig. 438), but in this case the actual obstruction will probably not be at the level of the diaphragm. If during the examination any of the opaque meal passes through the obstruction, the portion of œsophagus between the level of the diaphragm and the cardiac orifice will usually be found undilated (see Figs. 443, 450), although at times it may also be seen to be affected, the dilatation then extending to the cardiac orifice (see Fig. 451). Even in such cases there will generally be seen a very definite narrow constriction at the site of the diaphragm (see Fig. 452). As a rule an insufficient quantity of the meal passes through to permit definite examination of the stomach.

Another method of examination which was at one time more frequently used than at present was to make the patient swallow several pellets, some of which were heavier and some lighter than water. The position of the two different groups as seen by the X rays would give an indication of the site of the obstruction and the amount of dilatation of the œsophagus. The points of distinction from carcinoma of the œsophagus in the X-ray findings are that in the latter the dilatation is much less, the site of obstruction may be remote from the level of the diaphragm, and, if any of the meal passes, the constricted portion of the œsophagus is seen to be much longer and its outline to be very irregular.

The appearances seen with the œsophagoscope are also absolutely characteristic. As soon as the tube passes the cricoid (and in my own experience there has never been any abnormality until this structure has been reached), an enormous dilatation will be visible. The instrument looks along the surface of a large quantity of dirty fluid, and with each respiration the dilated œsophagus tends to open and close so that the fluid washes up and down the œsophagus, reminding one at once of the rise and fall of the waves of the sea in a closed cave. If this fluid is drawn off with a motor suction apparatus, it may be found to amount to a pint or more. The walls of the dilated œsophagus are then easily visible and are seen to be flattened and smooth, unless there is any secondary ulceration, in which case the shallow, reddened, and perhaps sloughing ulcers are easily recognized and are quite distinct from the raised nodular and irregular surface of an œsophageal carcinoma. With each respiration the cavity passively opens and closes, the air being audibly sucked in and out of the tube, so that the patient may be said to have an œsophageal respiration. On passing the tube further, the lower end of the œsophagus is reached. At times it may be difficult to distinguish the narrowed opening if the œsophagus is much bent or pouched, but if care is taken it can generally be distinguished. It will be seen to be tightly constricted, the surrounding walls being thrown into folds much in the same way as the folds are seen around the normally constricted anus. According to Brown Kelly, this opening may be seen to relax and contract. This has never been my experience. In all my cases it has remained tightly constricted throughout the whole examination, a finding which is in accord with the condition seen on X-ray examination, for with the latter method, in no case has a sudden gush of fluid been seen to pass into the stomach.

If a small bougie is passed down the œsophagoscope, it will pass through the opening only with great difficulty, and will be at once firmly gripped so that a considerable measure of force is required to withdraw it. I lay special stress upon this observation, for many observers, including Brown Kelly,⁸ Cameron,⁹ Hill,²⁵ Hurst,²² Tilley,⁵⁴ and others, state that a tube can easily be passed and is not gripped as it would be if the muscle were in spasm. Possibly my cases were far advanced and were in this respect different from those usually described, but a most constant fact was the inability to pass an ordinary tube, a bougie, or a mercury tube. A small bougie when passed through the œsophagoscope was entered only with difficulty and was always firmly gripped by the muscular wall, a fact to which further attention will have to be directed when the treatment is discussed.

CAUSATION.

It is when seeking for a cause of this curious condition that the greatest difficulty is met with. There are, however, certain other conditions with which it seems to be analogous; that is to say, there are other examples of a dilated and hypertrophied viscus in which there cannot be found post mortem any definite mechanical obstruction. It is well to mention that it is in no way comparable or analogous to congenital pyloric stenosis, although it has often been regarded as of a similar nature. In congenital pyloric stenosis there is an enormous hypertrophy of the pyloric sphincter, and it is self-evident that this hypertrophical structure is the cause of the obstruction, an obstruction which is maintained after death, so that fluids will often fail to pass through the canal. The other lesions which are similar to cardiospasm in that no such mechanical obstruction can be seen are Hirschsprung's disease or idiopathic dilatation of the colon, congenital or idiopathic dilatation of the bladder and ureters, and probably some cases of congenital cysts of the common bile-duct. In these conditions no hypertrophied sphincter has ever been demonstrated at the opening, and no fibrous or other congenital form of obstruction has been found. It is true that a few cases have been reported as examples of cardiospasm in which there has been a very definite thickening and hypertrophy of the sphincter at the cardia, but nearly all would agree that these cases should not be so grouped. The characteristic cases are not then due to a congenital hypertrophy of the muscular sphincter.

All the reported cases have shown not only an enormous dilatation of the lumen but also very great hypertrophy of the muscular coat, which is found on post-mortem examination and is evident as well from the powerful contractions which may be seen from the X-ray examination and which lead to the ejection of the fluid and food after it has collected in the œsophagus. It is therefore evident that the dilatation is not due to muscular paralysis. There is indeed evidence of the very reverse—a powerful and hypertrophied muscle attempting to overcome some obstruction which cannot be seen post mortem.

The fact that in some varieties the œsophagus was much lengthened and tortuous, so that generally a long loop lay over to the right, led to the view that the obstruction might be due to mere kinking of the œsophagus. Shaw and Woo support this view, for they say that it is the only theory which will account for the intermission of the symptoms. A similar view was at one time held by Plummer.⁴⁴ Such a theory is not tenable, for the greater number of the cases are either fusiform or flask-shaped and the opening of the œsophagus is thus at the lowest level so that no trace of a kink is discernible. Moreover, as Shattock⁵¹ has pointed out, if there were such a kink it would become permanent in long-standing cases and would be visible after death.

The view was at one time put forward by Martin that the lesion was due to a primary œsophagitis. If by this was meant that an inflammatory change had led to so much alteration in the wall of the œsophagus that it had become weakened and thickened, it may be answered that there is never any evidence of such weakening; in fact, the reverse is the case, the thickening of the

muscular wall being almost wholly due to hypertrophy of the muscular fibres, and the inflammatory changes being only slight in degree. It is possible, however, that any such inflammatory change might have led either to hypo-æsthesia of the upper part of the œsophagus so that a peristaltic wave was never started, or to a hyper-æsthesia of the cardia so that a spasm was produced at this area and hence the contents were not allowed to pass. These views have been carefully considered by Shattock,⁵⁰ who, although he found that if he anæsthetized the bladder of cats retention and dilatation of the bladder followed, was unable to accept either of them, for there is no evidence of such changes occurring in any of the reported cases; and in fact the hypo-æsthesia, or even complete anæsthesia, which is sometimes seen in the pharynx of hysterical people, is not associated either with dilatation of the œsophagus or with difficulty in swallowing.

Since it has been realized that the obstruction is at the level of the diaphragm and not at the cardiac orifice, the view has been held that the obstruction might be due to some congenital abnormality in the relationship of the œsophagus to the crura of the diaphragm. Hill,²¹ although he believed there was no actual spasm of the crura because there was no hiccough, was of the opinion that there was inco-ordination of the active movement of the diaphragm in opening the œsophagus as the food passed.

Shattock, in the discussion following this paper, pointed out that occasionally the œsophagus might pass through the right crura instead of between the two crura and thus it was conceivable that an anatomic variation might lead to an obstruction. In one case which he had seen of such an anatomical abnormality there was no evidence of any obstruction of the œsophagus. In none of the reported cases has there been produced any definite evidence of any abnormality at the opening of the diaphragm, and in all my own operated cases no such lesion could be distinguished. Those cases already mentioned in which the dilatation and hypertrophy extends below the diaphragm down to the cardiac orifice would seem very definitely to disprove this view. Shattock points out that even if the obstruction were at the cardiac orifice, the tone of the diaphragm might for a time prevent dilatation of the phrenocardiac segment.

The original theory put forward by von Mikulicz,³⁷ and later by Leichtenstein, was that the obstruction was due to spasm, the portion which was spasmodically contracted being then regarded as the cardiac sphincter. Of late a certain amount of discredit has been thrown upon this view, for both Hurst^{22,23} and Shattock⁵⁰ have stated that, if it were so, hypertrophy of the muscle would be expected such as occurs in congenital pyloric stenosis. It is of interest to note, however, that the mere fact that in this latter condition there is so much muscular hypertrophy is one of the arguments used against its being due to a spasm. In fact, as I have shown elsewhere,⁵⁶ the evidence is steadily accumulating that this pyloric lesion is a congenital deformity and is not spasmodic. The other argument which has been used, especially by Hurst, is that the mercury tube passes with the greatest ease and is never gripped as it would be in a spasmodic contraction. This experience is the reverse of my own. Perhaps because the cases sent to me are always in the late stages, never once have I been able to succeed in passing a mercury tube.

In some a subsequent skiagram has shown that the tube, instead of having passed through the cardia, has coiled up in the dilated œsophagus (*Fig. 439*), and if a small bougie is passed through the œsophagoscope, it is firmly gripped and a considerable amount of force is required to move it onwards or backwards. So evident is this that it is my custom always to demonstrate it to those assisting at the operation, and I regard the firm grip of the bougie as one of the classical signs of a true cardiospasm. Tilley⁵⁴ lays stress upon the fact that a very marked spasm follows the impaction of a foreign body or the presence of a small ulcer, and therefore believes that a prolonged spasm might easily give rise to such dilatation and hypertrophy. Harmer¹⁹ reports an interesting case, supporting this view, of a patient who had complete obstruction from impaction of a piece of carrot; this obstruction lasted ten days, and, as an X-ray film showed, was associated with a good deal of dilatation. It would



FIG. 439.—Mercury tube coiled up in the greatly dilated œsophagus of a case of cardiospasm.

thus seem that there is not sufficient evidence to exclude entirely the presence of spasm of the lower end of the œsophagus, but further search must be made for the cause of this spasm. Einhorn,¹¹ in 1888, first put forward the view that the obstruction might be due to inco-ordination of the muscular movements of the œsophageal wall, and of late this theory has been elaborated and more widely accepted. Shattock⁵⁰ states that the œsophagus is innervated by the vagi, and the conduction of a peristaltic wave does not depend upon an intramuscular nerve plexus, as it does in the case of the intestine. If the whole of the muscular tube is divided, and the nerve-supply is left intact, a peristaltic wave in the upper segment will still be transmitted to the lower; hence he does not agree with the view put forward by Parkes Weber⁴³ that there is a block similar to that of heart-block or to the block described by Sir A. Keith as occurring in the intestine. Hill²⁵ states that if the vagi are divided there follows dilatation

of the œsophagus and contraction of the cardia; but, as Shattock points out, no evidence has ever been produced that there is a lesion of the vagus. He shows, however, that normally the same impulse which causes the peristaltic wave leads to an active dilatation of the cardiac sphincter.

The views generally held to-day, then, are either the theory of co-ordination, or the one which holds that the condition is due to spasm: the latter would be supported by the facts that in the early stages the symptoms are often intermittent; that there is frequently severe pain such as would be expected with a spasmodic contraction; that on œsophagoscopic examination the opening is seen to be so tightly closed that a bougie when passed is firmly gripped; and that after death there is no trace of any obstruction. The chief objection to this view is that the obstruction is not as a rule at the site of the cardiac sphincter, where a spasm would be most expected to

occur. This objection, however, also holds for the theory of inco-ordination; that is, the view that there is a failure in the active relaxation or even dilatation which should occur with each peristaltic wave: for here again the portion which would normally be expected automatically to relax and contract with the peristaltic waves is the cardiac sphincter.

The theory of inco-ordination seems to have been more widely accepted because many observers are of the opinion that a bougie can be easily passed and is not gripped in its passage. In my experience this has never been the case, and therefore my own view at present is much more in favour of the theory of spasm. Why this spasm should be found so much more commonly at the level of the diaphragm and not at that of the cardiac sphincter cannot at present be explained. Much wider knowledge of the movements of the lower end of the normal œsophagus during feeding is required. It is quite possible that it will be found that the food is not held up by any definite sphincter, but that the whole lower inch or two of the œsophagus partakes in the sphincter action.

The acceptance of the view that the obstruction is due either to spasm or to inco-ordinate movements is not, however, a full explanation: a cause of such abnormal muscular movements must be looked for. The patients are most commonly of middle age or even well past this period. There is never discoverable any local lesion which might be regarded as the cause of the abnormal movements, and the symptoms are often of short duration. The other important fact upon which insufficient stress has, I think, been laid is that once the condition has developed there appears to be no tendency whatever to spontaneous cure. The symptoms always seem to progress, the obstruction and dilatation become more and more evident, and in the end the patient succumbs. This is the reverse of what would be expected if there were a spasm secondary to some small local lesion; and even if it were due to inco-ordination of the normal movements, so that the lower end fails to relax or even spasmodically contracts with each peristaltic movement, it is difficult to see why such inco-ordination should commence relatively late in life and should then persist with no intermission or relief. When it is remembered that a considerable number of cases have been reported in young infants; that many patients, although of adult life, when seeking treatment date their symptoms back to early childhood; that many who have had symptoms for but a short period yet show advanced pathological changes in the œsophagus; and that the condition when once recognizable is steadily progressive, the conclusion is forced upon one that the lesion must be congenital in origin.

The inco-ordinate action, whether it is spasmodic or simply a failure to relax, must have been present at birth; but in the early stages of life and while the muscular wall is healthy the peristaltic waves are able to overcome the obstruction, and symptoms are but slight or are entirely absent. Later, as the patient gets older, the muscle, although much hypertrophied, will fail to overcome the obstruction, and symptoms will commence. As soon as stagnation occurs the wall of the œsophagus will become inflamed, and thus its action will be further impaired. After an acute infection there may be a sudden failure of the muscular wall, and thus will be explained those

cases in which the symptoms can be recognized as starting at a definite date after some acute illness.

TREATMENT.

Since the obstruction at the level of the diaphragm, or in some of the later cases at the cardiac orifice, is always muscular in nature, treatment will naturally be directed towards dilating the muscular wall. The simplest method of attempting the dilatation is by the passage of a bougie from above. As already mentioned, many observers claim that there is never the slightest difficulty in passing an instrument in this way. This may be so in the early or slight cases, but in my own series it has never been possible when there was clear evidence from the X rays and œsophagoscopy of the established condition. Even with the use of the œsophagoscope only the smallest bougie could be passed, and there was much difficulty in gaining any improvement thereby. The same has also been my experience with the mercury tube, which has simply curled up in the œsophagus and failed to pass. It is of interest to note that some surgeons have found that, although a bougie or mercury tube has apparently passed, there has been little or no improvement, while others claim that their patients gain complete relief thereby.

Hurst²² advocates the passage of a mercury tube, which he says passes easily through the cardia, and he reports a case where the patient could retain nothing but is now able to swallow all meals if she uses the mercury tube immediately before each. The tube can be passed without any sense of obstruction and can be withdrawn without any difficulty. He stated then that the condition could always be relieved without any operation, but he has since reported a case with Rowlands²⁶ in which an operation had to be undertaken. French¹⁷ has apparently found that the passage of a bougie or tube is not always satisfactory, for he says that this should always be tried, but if it fails an operation should be undertaken. Box⁶ has had an experience very similar to my own, and reported a case where the X rays showed that the mercury tube had failed to pass and was coiled up in the œsophagus. Mutch⁴⁰ has had an interesting experience, for, though he states that bougies and the mercury tube are easily passed, he has seen patients who have used the mercury tube as often as thirty-five times a week with no permanent improvement. Hill²⁴ has also failed to get the uniformly gratifying results which others have obtained by these methods, and believes they are only of value where there is intrinsic anatomic narrowing.

The variation in the results obtained by so many observers would lead one to infer either that the bougies which have been thought to have passed have, owing to the increased length of the œsophagus, failed to enter the stomach, or that there are two distinct groups of cases, the one early or slight in which bougies can be passed, and the other late or severe—to which group my cases would naturally belong—in which no bougie can be passed beyond the constriction. It is of interest to note that several of my cases had been treated previously with bougies, but had obtained very little, if any, relief.

Dilatation by Rubber Inflation Tubes.—The fact that the passage of bougies did not give complete relief led to the invention of tubes which

could be passed down to the dilatation and there inflated. Such an instrument also possesses the advantage that its size is not limited by the calibre of the pharynx and upper portion of the œsophagus, which is the factor controlling the size of the simple bougies that can be introduced. Very many different forms of such an instrument have been used, but apparently the first was that suggested by Russell⁴⁹ in 1878. Since that time instruments have been devised by Stranss,⁵² Rosenbaum, Gottstein,¹⁸ and Plummer.⁴⁴ The latter is the best known and is the one which

to-day is almost universally used, although it is often modified in some slight detail. The instrument consists essentially of a hollow bougie of small calibre to the lower end of which acorn-shaped metal pieces of

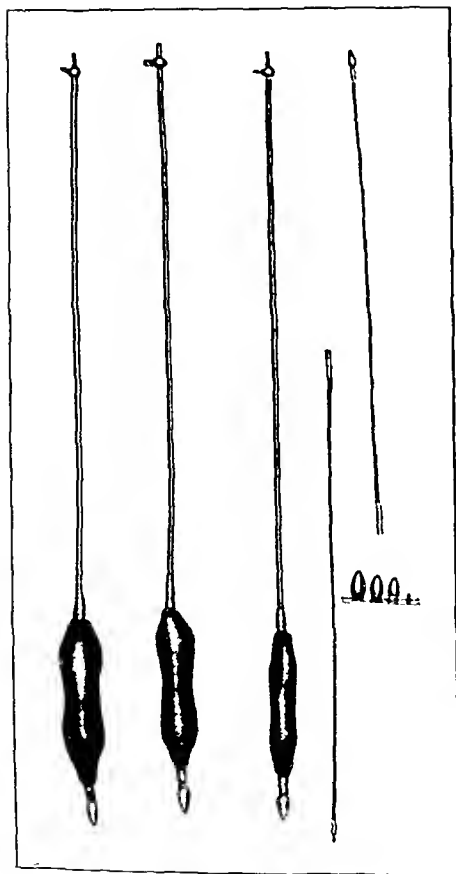


FIG. 440.—Different sizes of hydrostatic dilators.



FIG. 441.—Plummer's hydrostatic dilator coiled in the much dilated œsophagus of a case of cardiospasm.

different sizes can be screwed; above these is a rubber bag about 3 in. long, firmly fixed around the bougie and with the cavity of which the hollow of the bougie communicates (Fig. 440). The bougie is passed until the acorn head goes through the obstruction and the bag lies with its centre opposite the obstruction. A head of water with a manometer to register pressure is attached to the end of the bougie; the bag can thereby be dilated under any required pressure. The amount advocated by Plummer and Porter⁴⁵ is a pressure equal to thirty feet of water. If the obstruction be tight, and it is difficult to pass the bougie, which tends to enter the

sulcus around the opening and to kink in the dilated œsophagus (*Fig. 441*), the patient is made to swallow a shot to which a fine silk string is attached. The other end of the silk is wound on a reel and from time to time a little more silk is swallowed. After a while the shot passes through to the stomach, and the silk will then act as a guide down which the acorn-shaped metal head, which is pierced, can be passed and so made to enter the stomach. Jordan²⁹ advocates that the silk be kept on a reel and a little more swallowed from time to time until the shot is passed per anum. The bougie is then threaded on the silk and there is no doubt but that it has passed the obstruction. The use of this form of dilator has become very popular, and extremely good results have been claimed from its use. In some cases where the constriction is very narrow it may be necessary to dilate it with simple bougies before the bag, which is of a considerable size, can be made to enter. Gottstein¹⁸ used a bag which was modified in that there was a layer of canvas between two layers of rubber. Since it was stouter than the ordinary bag he claimed that it would not dilate above and below, and leave the constriction undilated. With its use he treated 6 cases in two and a half years and obtained thereby 5 complete cures; the sixth case could not afford to give the necessary time or might also have been cured. Zaaiger⁵⁹ found that it was necessary to operate in only very few cases, for in nearly all the dilator could be passed and the obstruction dilated with it. Watts⁵⁷ had a very similar experience, finding only a very few cases in which a dilator could not be passed.

The most important and the largest series of figures are those that were published by Plummer. In 1912⁴⁶ he reported a series of 91 cases, 73 of which were completely cured, 11 were not completely cured, 4 died, and 3 were not traced. In a later series published in 1921 he reports with Porter and Vinson⁴⁵ a series of 301 cases in which 75 per cent were relieved by divulsion with the hydrostatic dilator, and he states here that those cases with great dilatation are the cases which respond particularly well to this form of treatment.

With the figures of so large a number of cases it is difficult to understand why the majority of my own cases should have been so intractable. Although I am willing to admit that to a certain extent this may be due to lack of experience in the use of the dilator, this cannot be the sole explanation. In all the patients careful attempts were made to dilate the obstruction, at first through the œsophagoscope and later without it. In all there was a constant failure to gain any improvement. The smallest bougies alone could be passed and all were firmly gripped. Never could the opening be dilated to within any measurable degree of admitting the dilator. In several, moreover, previous attempts at this form of treatment had been carried out elsewhere with no success. The only possible explanation is that in a certain number of cases which have been more severe from the commencement or may have progressed to a later stage, the opening is so small and is so rigidly held that no bougie or dilator can be passed. Such late cases, which are often those that have failed to react to other forms of treatment, will naturally be the ones that fall into the hands of the surgeon, and thus it is that nearly all my cases have been of this variety.

There can be no question at all, in view of Plummer's results, that his method of dilatation should first be tried; but there is also no question at all that there are a certain number of cases—and these are the ones which from the severity of their symptoms are most likely to be mistaken for malignant disease of the œsophagus or stomach—where the passage of a bougie or hydrostatic dilatation will be quite impossible. This is no new discovery, for Erdmann,¹⁴ Lambert,²⁰ and many others who have reported operative procedures have laid stress upon the fact that operation should be carried out only in those cases where dilatation from above is not possible. It is, however, important to realize that these cases are not so uncommon as has been thought, for of my 16 cases occurring in a period of ten years 14 were of sufficient severity to require operative treatment, dilatation from above having been found impossible.

Digital Dilatation through the Opened Stomach.—It is interesting to note that Mikulicz,³⁷ who first directed serious attention to this condition, advocated digital dilatation from below through the opened stomach. His method was to introduce the hand into the stomach and then, by inserting the fingers up the lower end of the œsophagus, slowly and steadily to dilate the muscle to such an extent that it was paralysed and remained permanently dilated. In some unsuccessful cases the œsophagus was ruptured and the patient died. There is no doubt that this unfortunate accident did much to discredit what I believe is the most satisfactory and, if carefully performed, by far the safest method of treating these advanced and difficult cases. Since Mikulicz published his method it has been performed by many surgeons. Erdmann¹⁴ advocates it as the method of choice if dilatation with the hydrostatic dilator fails. In his first case it is true there was some recurrence of symptoms after six years, but this was probably because the dilatation had not been carried to a sufficient degree. Bowker⁴ reported an interesting case where Rushton Parker had dilated from below with a complete cure, and later X rays showed the œsophagus collapsed instead of extensively dilated as it had been previously. Since then most of the reports have been of single cases, but Pamperl⁴¹ collected 14 cases treated by this method, of which 12 were cured and 2 relieved. Thieding⁵³ reported 3 more successful cases.

My own experience of the condition is based upon 16 cases; 2 of these were of slight degree and the symptoms were completely cured by the passage of bougies; the remaining 14 were of an advanced degree and showed characteristic symptoms and X-ray and œsophagoscopic pictures. They were all treated by the Mikulicz method with very satisfactory results, no further operative or other treatment being necessary. Before considering in detail these cases and the results of their treatment, it will be well to describe the actual operative steps of the Mikulicz operation. In no case should an operation be performed unless the typical X-ray picture and appearances on examination with the œsophagoscope are seen. Operative treatment should also be reserved for those cases in which dilatation from above is not possible or has to be repeated at such short intervals that it is extremely irksome.

A general anæsthetic should be given and an œsophageal rubber tube

passed. This will often readily pass for a distance that is several inches beyond which it should normally have entered the stomach, but it will still be within the lengthened and dilated œsophagus. The upper abdomen is now opened by the usual upper right pararectal incision and the stomach withdrawn. The viscus should be examined so that any obstructive lesions of the pylorus or elsewhere in the stomach, to which the œsophageal dilatation might be secondary, are not overlooked. If it is found to be normal, a longitudinal incision is made in its anterior wall midway between the lesser and greater curvatures and of sufficient length to admit the right hand. The cut edges may bleed freely, and the bleeding points are clamped with forceps, which may then be used to elevate the stomach. By their aid the stomach is held well up by an assistant and the rest of the wound carefully packed off. The right hand is then inserted into the stomach and up to the œsophageal opening. The index finger is now passed through this and up the œsophagus. There is often a certain amount of difficulty; but with steady, gentle pressure it will pass. It is, however, quite evident to this finger that there is a very definite obstruction. The tube can be felt in the œsophagus, and if care is not taken there may be a considerable gush of foul fluid from the œsophagus down into the wound. It is to avoid this that the tube is passed at the commencement of the operation and the stomach is not only held well up but is packed off from the abdominal wound and cavity. As soon as the index finger has entered its full length the middle finger is gradually inserted alongside it, the constricted portion being thereby dilated. When the two fingers have entered they are gradually separated so as to stretch the opening. It is generally evident at this stage that the narrowed portion is not at the cardiac orifice, but is well above it at the site of the passage of the œsophagus through the diaphragm. When the two fingers have freely dilated the opening the ring finger and then the little finger are inserted.

The whole dilatation must be carried out most carefully, it being the surgeon's aim to dilate the whole œsophagus to its fullest extent without rupturing it. This can only be accomplished by a most careful use of the sense of touch, and thus the fingers should alone be used. Several pairs of forceps have been devised for carrying out this dilatation from below, but they are all dangerous in that without the sense of direct touch it is impossible to determine the amount of dilatation, and the danger of rupture with a subsequent fatal mediastinitis would be considerable. As soon as the lower end of the œsophagus has been fully dilated, the opening in the stomach is sutured by two layers of catgut sutures and the wound closed. In my earlier cases it was my custom to pass the œsophageal tube down into the stomach and feed the patient through it for a few days. It is, however, a most uncomfortable procedure, and further experience has shown that it is unnecessary. For the first twenty-four hours after operation the patient is given sips of water only by the mouth. On the second day other fluids, such as milk and tea, are added. Jellies and junket are allowed on the third day, and more solid food is then gradually added, the patient taking a full diet at the end of ten days. All the symptoms have now ceased, and he is able to live a normal life and to continue with a full diet.

PARTICULARS OF CASES.

The details of my cases are as follows :—

Case 1.—H. C., a male, age 50, first seen on Aug. 25, 1913, was quite well until a year before this, when he commenced to have occasional difficulty in swallowing solids. This steadily increased so that at this time even fluids returned unless taken very slowly. He stated that at times he could take half or nearly all a meal, which was then returned unaltered. There had never been any hæmatemesis. He had a little sense of discomfort but no real pain.

ON EXAMINATION he was found to be a well-developed healthy-looking man who showed only a moderate amount of wasting. An X-ray was taken after the administration of a bismuth pill, which was found to drop straight to the diaphragm. On the 26th he was œsophagoscoped under general anæsthesia. The instrument was easily passed, and immediately below the cricoid the œsophagus was found to be enormously distended and full of a greenish fluid. This was drawn off with a suction apparatus. The opening was seen to be tightly constricted, but there was no evidence of any scars, stenosis, or growth. A bougie could not be passed through the constricted opening. A further X-ray was taken on Sept. 16, light and heavy pills being given. The heavy sank to the diaphragm and the light was seen floating on the top of some water which had been given. The outline of a much dilated œsophagus was visible. Attempts were made to dilate the cardiac orifice by the passage of small bougies. At first success was obtained by passing these through the œsophagoscope, but attempts at dilatation were unsatisfactory, although he improved and gained a little weight under this treatment. He was sent away to a convalescent home with the dilators, but his symptoms returned, and in January, 1914, the abdomen was opened, the hand inserted into the stomach, and the cardiac orifice dilated till four fingers were passed easily. Since that time he has remained free from symptoms and has been able to take all food well.

Case 2.—R. H., a male, age 59, was first seen on Jan. 18, 1916. He stated that for twenty years he had suffered with indigestion. About every three months he would have an attack of epigastric pain which was increased almost immediately after meals but continued on and off for several days. For five years there had been pain in the lower abdomen, which was continuous and gnawing. At first it had sometimes been violent and was most marked an hour before meals. It would wake him at night, and he was relieved by vomiting and taking meals. From this period he had commenced to regurgitate some of his food. At first this would occur during the course of the meal, but now it only took place after the meal was finished. The returned material was apparently undigested.

ON EXAMINATION he was found to be a thin, wasted man with no physical signs in the neck, thorax, or abdomen. A test meal showed absent free HCl and a total acidity of 13. (The meal had certainly never entered the stomach.) A skiagram after an opaque meal showed a greatly dilated œsophagus with a complete smooth obstruction at the lower end. On Jan. 5 he was examined with the œsophagoscope and the typical appearance of cardiospasm was seen. The opening was tightly constricted, but a small bougie could be passed. With time and care the bougies were increased until a No. 19 was passed successfully. After this he showed little or no improvement. His food was still regurgitated and there was still discomfort. On Jan. 21 the abdomen was opened, and the œsophagus dilated by the fingers from below. He made a good recovery and remained free from all symptoms for four years. Since then he has been lost sight of.

Case 3.—L. S., a female, age 54, was first seen on June 19, 1917. For six years she complained of abdominal pain after food. For three years this became more frequent and severe. It was present about half an hour after food, situated in the epigastrium and radiating to the back. It was periodic, the attacks lasting from two to three days with intervals of comparative freedom of a few days only. Pain was always relieved by vomiting. For six months the pain had become continuous and

passed through to the shoulders. It was increased almost immediately after meals. Vomiting had become more evident and was present after every meal; it gave some relief to the pain.

ON EXAMINATION she was found to be a very thin and feeble woman with a flabby abdomen. There was no clinical evidence of any dilatation of the stomach, and no tumour could be felt. A test meal showed absence of free HCl., and a total acidity of 4 (from œsophagus only). On examination with the œsophagoscope the typical dilatation of a cardiospasm was seen, the orifice forming a tightly-closed slit through which bougies could not be passed. On June 20 the abdomen was opened, the hand was inserted into an opening in the stomach and the cardiac orifice and fully dilated. Except for a certain amount of post-operative bronchitis the patient made an uninterrupted recovery and was able to swallow all foods easily. She has since remained free of all symptoms and has required no further treatment.

Case 4.—T. R., a male, age 51, was first seen on Dec. 31, 1917. For one year he had had some difficulty in swallowing. His food seemed to stick in the epigastrium and caused pain. After about ten minutes it returned with a quantity of mucus. After this time he had a variable amount of difficulty. At times there would be a little discomfort, when food would pass. At other times the discomfort would be more marked and he would bring up his food twice or thrice daily. Sometimes the regurgitation would occur after he had taken a few mouthfuls: at others nearly the whole of the meal would stay down. His general health had suffered but little.

ON EXAMINATION he was found to be a well-developed healthy-looking man with little or no wasting and no physical signs in the abdomen or thorax. The X-ray examination showed much obstruction of the cardiac end of the stomach with a great deal of dilatation above it. There was no irregularity of the lumen and no evidence of aneurysm. He was examined with the œsophagoscope in January, 1913, when characteristic appearances were seen. Here again there was much constriction of the cardiac orifice, with no evidence of any growth. Only a small bougie could be passed from above, and was tightly gripped. Laparotomy was therefore performed and the cardiac orifice dilated from below in the usual way, two fingers only being inserted. A large œsophageal tube was passed from above and was left *in situ*. The patient made an uninterrupted recovery. The œsophageal tube caused a considerable amount of discomfort, but he was able to retain it for four days. After this it was withdrawn and he was then able to take food well. He progressed very favourably, but died suddenly on Sept. 29, 1923, nearly five years after his operation. A letter from his relatives stated that he had a certain amount of discomfort in swallowing and occasional regurgitation towards the end of his life. He sometimes passed an œsophageal tube, which relieved this. The cause of death was not known.

Case 5.—R. G., a male, age 73, was first seen on April 10, 1918. He stated that he had been perfectly well until six days ago, when he felt sick and vomited quantities of white mucus. There was no pain, but he was afraid to swallow food. A certain amount of food could be taken and retained for fifteen minutes, but was then returned.

ON EXAMINATION he was found to be considerably wasted, but there were no other physical signs. An X-ray report showed that there was a considerable amount of dilatation of the œsophagus with a spasm at the cardiac end. These spasms would hold up the food for some time and then would relax and allow the food to pass through. The interesting point was that there appeared to be more than one level of the spasm, so that the lower 3 in. of the œsophagus appeared to be segmented. Each of these areas of spasm would relax. On œsophagoscopy only a moderate amount of dilatation was seen, and at the lower end there was a spasmodic contraction which would relax. Bougies could be passed fairly readily, although they were slightly gripped.

This condition was regarded as one of an earlier stage than the usual cardiospasm, and after dilatation with the bougies the patient was greatly relieved. He made very good progress after operation. He died six years later of sarcoma of the chest wall in Whipp's Cross Hospital. He was then free from œsophageal symptoms.

Case 6.—A. A. (referred to me by Dr. R. Hutchison), a female, age 63, was first seen on Sept. 27, 1918. She stated that she had been subject to sickness all her life, but for four years she had had in addition a considerable amount of ill-defined pain in the epigastrium immediately after food. The vomiting had continued, and for the last six weeks had taken place once or twice a day. It was effortless and not preceded by nausea. There was usually a feeling of shivering, and the temperature went up to 101° before the vomiting. The vomit was in many cases very large.

ON EXAMINATION she was found to be a pale, slightly anæmic woman who was somewhat wasted. There were no physical signs in the abdomen and no evidence of any dilatation of the stomach. The test meal showed a trace only of free HCl and a total acidity of 64 (probably œsophageal). The X rays showed a large shadow to the right of the dorsal vertebrae into which the meal passed, and on the patient's lying down the meal was seen to fill a large cavity in this area. A small stream was seen passing into the stomach, but the remains of the meal were found in the œsophagus twenty-four hours after it was ingested. On œsophagoscopy an enormous dilatation was seen, and over a pint of fluid was siphoned out. After removal the œsophagus was found to be 3 in. in diameter, but the walls did not wholly collapse. The abdomen was opened from below a week later and the œsophagus dilated in the usual way until four fingers could be passed. An œsophageal tube was then passed and fixed in position. This gave a considerable amount of discomfort, and was removed in six days. The patient made an uninterrupted recovery and has remained perfectly well since. A letter received on Sept. 26, 1924, six years after operation, states: "I have not had the slightest recurrence of my trouble, and I have remained in excellent health ever since."

Case 7.—H. B., a female, age 54, was first seen on July 28, 1919. Two years before she commenced to have pain in the chest and epigastrium. It came on during the meal and persisted for some time. She had been vomiting up her food, which seemed to stick in the epigastrium, and the pain was then relieved. On admission she stated that she was then vomiting after every meal.

ON EXAMINATION she was found to be a small woman who was not much wasted and who showed no physical signs in the thorax or abdomen. Œsophagoscopy revealed great dilatation of the œsophagus with tight closure at the level of the diaphragm. There was no evidence of any fibrous stricture or overgrowth. The usual dilatation was carried out digitally from below, and in this case there was noted for the first time that the cardiac orifice was normal, but that there was a tight constriction about 1 in. above it at the level of the diaphragm. This opening was fully dilated until four fingers could be inserted. The wound was closed, no tube being inserted. For the first few days after operation there was a considerable amount of vomiting, after which the patient made an uninterrupted recovery. She has been seen from time to time since, and in March, 1920, a skiagram was taken; she was then quite free from all symptoms. The meal passed at once into the stomach with no evidence of any hindrance, but in its passage was spread over a relatively wide area, suggesting that there was an enlarged although collapsed œsophagus. She is now seen at intervals of six months, and on her last appearance on March 4, 1924, was in perfect health, being able to take all food well with no pain or vomiting.

Case 8.—W. M. (referred to me by Dr. Warner), a male, age 48, was first seen on Nov. 13, 1919. For one year he had had attacks of pain across the epigastrium which were associated with vomiting, and the pain was always relieved thereby. It was situated in the epigastrium, was severe, and would often wake him at night, but in addition there was a constant dull aching pain. His vomiting occurred immediately after taking food, but in spite of this he was always hungry. He had been losing weight for three years and had now lost nearly three stone.

ON EXAMINATION there were no abnormal physical signs to be made out. His test meal showed an absence of free HCl and a total acidity of 30 (? from œsophagus). His X-ray examination showed a definite obstruction at the cardiac end of the œsophagus with much dilatation above it. The outline of the obstruction was thought

to be irregular and suggested carcinoma (*Fig. 442*). Owing to the X-ray appearance a diagnosis of carcinoma was accepted, and unfortunately œsophagoscopy was not carried out. The abdomen was opened on Nov. 19, and no growth being felt below the diaphragm, a gastrostomy was performed with the idea of attempting to remove the carcinoma later from the thorax. On Nov. 22 the thorax was opened by a long oblique incision between the sixth and seventh ribs, opening the pleural cavity. The pleura over the descending aorta was then incised, but the œsophagus could not be found in its usual position. A bougie was then passed from above, and it was found that the œsophagus had passed far over to the right behind the right pleura, and had in fact formed a loop. This was freed, and no trace of carcinoma could be found, it now becoming evident that the condition was one of cardiospasm. The bougie, with some difficulty, and being guided from the wound, was passed through the diaphragm into the stomach. The wound was then closed. The patient made a good recovery from this, and for a time was able to take his food well. Some additional food was given through the gastrostomy. He gained a considerable amount of weight, but on April 9, 1920, had a recurrence of his obstruction. He



FIG. 442.—Case 8. Appearance of œsophagus before operation.

was readmitted to hospital and œsophago-scoped, the examination revealing the typical appearance of cardiospasm. A bougie could be passed, but was felt to be tightly gripped, the area of constriction being $16\frac{3}{4}$ in. from the teeth. The obstruction was therefore dilated from below in the usual way, the gastrostomy being closed. The patient made an uninterrupted recovery and has remained well since. The last note taken on June 6, 1924, four years after his operation, says that he is very well and that he can now eat anything; he has no pain and is living a normal life.

Case 9.—M. H. (referred to me by Dr. Bulloch), a female, age 47, was first seen on Nov. 18, 1919. For four months she had been having regurgitation of food, generally after meals. With this there was a good deal of pain in the epigastrium and some flatulence. She had been losing weight lately. She was somewhat thin and wasted, and was very nervous and upset, for she had been told by a throat specialist that she had an inoperable cancer of the gullet.

ON EXAMINATION no abnormal physical signs could be made out, but there was a little tenderness in the epigastrium. The X-ray film showed a slight dilatation of the lower end of the œsophagus with a little delay, but this was only to a very slight degree. Examination with the œsophagoscope revealed only a slight amount of dilatation of the lower part. There was no evidence of any growth or fibrous stricture. Bougies were easily passed and there was only slight, if any, grip at the lower end of the œsophagus. She made a rapid recovery and within a few days was able to swallow all foods and fluids well. Since that time she has been seen at regular intervals, and in June, 1924, still remained quite free from all symptoms and in perfect health.

Case 10.—M. S. (referred to me by Dr. Sears), a female, age 42, was first seen on Feb. 2, 1921. Two and a half years ago after bathing on a cold day she noticed that she had some difficulty in swallowing. On returning home from her holiday she saw a doctor, who passed a bougie. She was then sent to Matlock, where bougies were passed at regular intervals, but gave only slight relief. In September, 1918,

she saw a specialist, and, after consultation and an X-ray photograph, her œsophagus was dilated with bougies through a large endoscopic tube; this gave her little or no relief. She continued to have a varying amount of difficulty, which on the whole was rather more marked for fluids than for solids. There was a special difficulty in taking a large draught of any fluid. In May, 1920, she was given a course of treatment by suggestion, but this gave her no relief.

ON EXAMINATION she was found to be a somewhat wasted but otherwise healthy-looking woman. There were no physical signs to be made out in the thorax or abdomen. An X-ray photograph (*Fig. 443*) showed a typical dilatation with delay at the phrenic level and a very slow small passage of fluid through into the stomach. Examination with the œsophagoscope revealed a typical dilatation with the retention of a large quantity of fluid and a tightly constricted cardiac orifice, through which a small bougie could be passed, but was firmly gripped. The usual digital dilatation was therefore carried out from below on Feb. 20, 1921, the opening being easily dilated up to admit four fingers. The wound was closed, no tube being

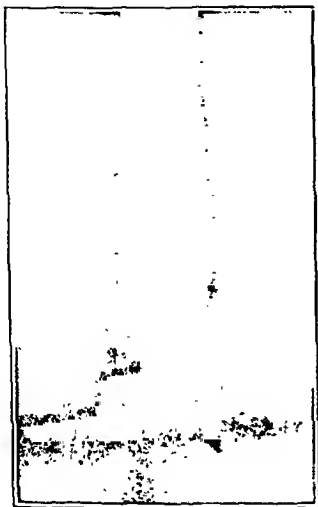


FIG. 443.—Case 10. Appearance of œsophagus before operation.

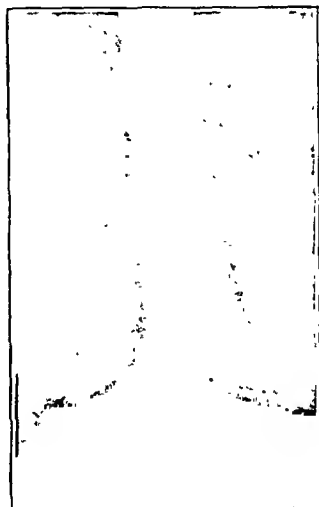


FIG. 444.—Case 10. Appearance of œsophagus one month after operation.

passed. She made very good progress, and at the end of a fortnight was able to take all food by mouth. A skiagram taken in March, 1921 (*Fig. 444*) showed very little delay. The œsophagus, although narrow, was irregular, suggesting that the fluid was rapidly passing through a narrowed canal. She remained well and never had any recurrence of her œsophageal symptoms, but fourteen months later she contracted cerebrospinal meningitis, from which she died. At the time of her death she was absolutely free from any œsophageal symptoms.

Case 11.—F. T. (referred to me by Dr. Finzi), a male, age 51, was first seen on July 11, 1921. He had been well until six years before, when he began to have some indigestion. In 1917 his food seemed to stick after about half a meal had been taken. This feeling of obstruction increased until, when seen, he was able to swallow practically nothing. He especially noticed a difficulty in taking a large drink. All fluids had to be drunk in small sips. In 1918 he saw a specialist, who dilated his œsophagus with bougies, which gave him slight and transient relief. Since then his difficulty had been very marked and he had a considerable amount of wasting.

ON EXAMINATION he was found to be a slightly wasted though healthy man

presenting no physical signs. The œsophagoscopy was not carried out, as this had been previously performed and the diagnosis confirmed. The X rays (*Fig. 445*), however, revealed an enormous dilatation with some curving of the œsophagus to



Fig. 445.—*Case 11.* Appearance of œsophagus before operation.

the right, the dilatation ending abruptly at the level of the diaphragm. An operation was carried out on Oct. 15, and the œsophagus dilated from below. One finger when passed found a very definite obstruction at the level of the diaphragm, the finger being firmly gripped. With slow and careful dilatation the opening was enlarged until four fingers could be passed beyond the proximal interphalangeal joint. The wound was then closed. Ten days later he was swallowing all food well and experienced no pain or obstruction. He remained well, and six months later when a skiagram was taken he had no symptoms of any sort. The film had to be rapidly snapped while he was swallowing, for the meal passed very quickly down the œsophagus. *Figs. 446 and 447* give the appearance of a large and flabby tube with rapid peristaltic waves, so that, although there was no obstruction, there still appeared to be dilatation. Since then he has remained free from all symptoms. A letter dated October, 1924, states that he is a new man, is able to swallow everything, and has no symptoms.



Figs. 446 and 447.—*Case 11.* Appearance of œsophagus six months after operation.

Case 12.—F. F., a male, age 31, was first seen on Sept. 19, 1921. For about ten years he had complained of indigestion after meals, the symptoms at first being periodic, so that he would have an attack lasting for about a week and then be free for about four or five weeks. The attacks had been getting more frequent

and severe. There was now a dull, gnawing pain high up in the epigastrium and radiating down both sides. It came on immediately after food and sometimes even while food was being taken. It was relieved by vomiting, which occurred during most attacks. The vomit contained a large amount of mucus.

ON EXAMINATION he was a healthy-looking man who showed a certain amount of tenderness in the epigastrium. There was a wide band of hyperæsthesia extending from the 5th to the 10th dorsal segment on both sides on the front of the abdomen. A test meal showed no free HCl and a total acidity of 5. The X rays revealed a greatly dilated œsophagus along its whole length, the obstruction being situated at the level of the diaphragm. Œsophagoscopy was carried out on Sept. 21, and showed a characteristic dilatation of the œsophagus which contained a large quantity of food and fluid. When this was siphoned off a tightly-constricted opening was seen at the level of the diaphragm and there was no evidence of any growth. An operation was therefore performed, the opening being digitally dilated from below in the usual manner until four fingers could be passed. Two days after the operation he vomited a good deal of bright-red blood, probably from the gastric incision. This, however, ceased and he then made a rapid recovery and was soon able to swallow all food well. He has been seen at short intervals since. He states that occasionally he has a very slight amount of pain, but that there is never any difficulty in swallowing his food and that he is able to take a full diet.



FIG. 448.—Case 13. Appearance of œsophagus before operation.



FIG. 449.—Case 13. Appearance of œsophagus before operation.

Case 13.—H. R., a male, age 65, was first seen on Dec. 12, 1922. He had been quite well until two years ago. He was then in a hospital with double pneumonia, and immediately after leaving he commenced to have loss of appetite and vomiting. He was then admitted to a hospital in South Africa and operated upon nine months ago in the belief that he was suffering from carcinoma of the pylorus. Nothing abnormal was found in the stomach, and his appendix was removed. He had little or no relief following this operation and has now continuous discomfort in the right hypogastrium, which is greatly increased even with the smallest quantity of solid food. For some months he has been passing a tube in the belief that he is washing out his stomach. He has had a good deal of regurgitation, which is more marked immediately after meals. His appetite is good, but he is afraid to eat.

ON EXAMINATION he was found to be a thin, wasted old man with a retracted abdomen. There was some splashing over the stomach, but no tumour could be felt. A test meal withdrew some semi-digested food but no blood. There was no free HCl,

and the total acidity was 30. The X rays showed characteristic dilatation of the œsophagus with obstruction at the cardiac orifice (*Figs. 448, 449*). The œsophagoscopy examination was in every way characteristic of cardiospasm. An operation was performed on Jan. 1, the abdomen being opened in the usual way and the lower end of the œsophagus dilated; the obstruction even in this case was definitely not at the cardiac orifice, but at the level of the diaphragm. Four fingers were passed until the opening was fully dilated. The wound was closed in the usual way and he made a rapid recovery. At the end of six months he was completely free from symptoms. He then returned to South Africa, and has just written that he is in perfect health.

Case 14.—F. M. (referred to me by Sir Thomas Parkinson), a male, age 66, was first seen on Feb. 1, 1923. He stated that he had been quite well until the end of 1918, when he had had attacks of vomiting, which at first were periodic but had later become continuous. He had a certain amount of epigastric discomfort and would return his food immediately after meals. Sometimes there would be regurgitation after only a few mouthfuls. In 1919 he was X-rayed and seen by surgeons, who advocated the passage of a tube and administration of belladonna. He had a slight amount of relief from this form of treatment, but would still vomit, and sometimes after a meal would bring up more than he had taken. The returned fluid was often more than a pint, and the regurgitation was most marked at night.

ON EXAMINATION he was a tall, well-developed but much wasted man. There were no physical signs in the abdomen and nothing abnormal could be found in the neck. He had an extreme degree of myocardial degeneration, the heart being considerably dilated and his pulse very rapid and irregular. A skiagram showed a characteristic dilatation, with the obstruction at the level of the diaphragm. The œsophagoscope revealed also the characteristic changes of a cardiospasm. The question of operation, in view of his heart condition, was very carefully considered. He was urgently desirous that something should be done, and was prepared to take any risk, and therefore I consented to operate. The usual operation was done on Feb. 2, the orifice being dilated to admit four fingers. Immediately after operation his progress was good, but seven days later he developed cardiac failure and died.



FIG. 450.—*Case 15.* Appearance of œsophagus before operation.

Case 15.—M. K. (referred to me by Lord Dawson), a female, age 31, was first seen on April 26, 1923. She stated that she had been well until October, 1920. She then noticed that during the course of a meal her food sometimes returned. After a small quantity had regurgitated she was able to return to her meal. On the advice of her doctor, bougies were passed and the stomach was washed out through a tube. She had very little relief from this and was unable to swallow solid food. A skiagram was taken at that time and the lower end of the œsophagus was found to be obstructed. A mercury tube was then passed, which gave a certain amount of mild relief, but for the next year she lived a somewhat invalid life and was never able to swallow fluids, and

solid foods only with difficulty. In 1922 she was œsophagoscoped and dilatation was carried out six times with a hydrostatic dilator. A year ago she was pregnant and was told that with the pregnancy she would probably be better, presumably on the assumption that the change was functional. She had, however, obtained very little relief.

ON EXAMINATION she was found to be a very thin and wasted woman with no physical signs in the abdomen, and nothing abnormal could be found in the neck or thorax. X rays (*Fig. 450*) showed a typical dilatation at the lower end of the

œsophagus. A certain amount of meal passed into the stomach and it was seen that the portion of the œsophagus between the diaphragm and stomach was not dilated. Œsophagoscopy revealed the characteristic change, there being a large quantity of fluid and a much dilated œsophagus. The opening was constricted. It would admit a bougie, but this was firmly gripped. Operation was therefore performed on May 9, 1923, the lower end of the œsophagus being dilated digitally from the stomach until four fingers could be passed. She made a rapid recovery from the operation and in a little over a fortnight was able to swallow all food without pain and with no signs of discomfort. She continued to make good progress, and a year later was in perfect health, feeling much better and stronger and having no difficulty in swallowing.

Case 16.—T. S. (referred to me by Mr. Lett), a male, age 64, was first seen on July 24, 1924. He had been quite well until three years ago, when he began to have some pain in the left side of the abdomen which was always most marked after food. Shortly after he commenced to have regurgitation and the feeling that the passage of his food was obstructed. This feeling was more marked with fluids than with solids, so that he was unable to take a long drink. He was in the habit of inducing vomiting before going to bed, otherwise the regurgitation at night would keep him awake. He noted that some of the returned food contained articles taken two meals before.

ON EXAMINATION he was a well-developed healthy-looking man with no physical signs in abdomen or thorax. Skiagrams (Figs. 451, 452) showed a wide dilatation

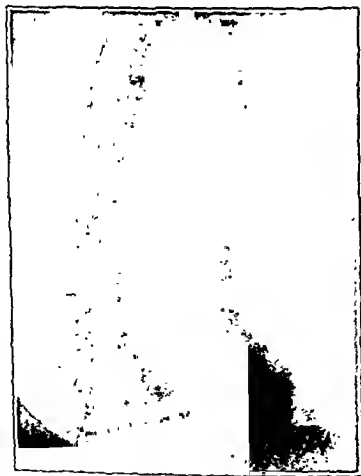


FIG. 451.—*Case 16.* Appearance of œsophagus before operation.



FIG. 452.—*Case 16.* Appearance of œsophagus before operation.

of the œsophagus which passed down as low as the cardiac orifice, but there was a definite constriction at the site of the diaphragm. Œsophagoscopy revealed a characteristic condition of cardiospasm. The œsophagus was very much dilated and contained a large amount of fluid. A bougie could be passed, but was very firmly gripped, and attempts at dilatation with graduated bougies passed through the œsophagoscope failed, for on each occasion the dilatation was slight, and when repeated only the smallest bougie could be passed. An attempt was made immediately after dilatation to introduce Plummer's hydrostatic dilator, but this failed to enter and remained kinked in the œsophagus (*see Fig. 441*). On Aug. 17 an operation was therefore performed, the abdomen being opened and the lower end of the œsophagus digitally dilated from the opened stomach. After four fingers had been

SYNOPSIS OF T

	NAME	DATE	SEX	AGE	TIME	Symptoms	Signs
1	H. C.	1913	M	50	1 year	Difficulty in swallowing. Returns half or whole meal	Wasted
2	R. H.	1916	M	59	20 years	Periodic pain, epigastric. Vomiting after meals	Wasted
3	L. S.	1917	F	54	6 years	Periodic pain half an hour after food. Vomiting. Thought to be gastric ulcer	Wasted
4	T. R.	1917	M	51	1 year	Difficulty in swallowing. Regurgitation of food	Wasted
5	R. G.	1918	M	73	6 days	Difficulty in swallowing. Regurgitation after quarter of an hour	—
6	A. A.	1918	F	63	4 years	Vomiting in childhood. Increasing	Wasted
7	H. B.	1919	F	54	2 years	Epigastric pain. Vomiting after meals	Wasted
8	W. M.	1919	M	48	1 year	Epigastric pain. Vomiting after meals	Wasted
9	M. H.	1919	F	47	4 months	Regurgitation, pain and difficulty in swallowing	Nil
10	M. S.	1921	F	42	2½ years	Pain and difficulty. Much vomiting	Wasted
11	F. T.	1921	M	51	6 years	Difficulty in swallowing, especially fluids	Wasted
12	F. F.	1921	M	31	10 years	Pain after food, periodic. Vomiting	Wasted
13	H. R.	1922	M	65	2 years	Vomiting. Loss of appetite. Laparotomy for carcinoma	Wasted
14	F. M.	1923	M	66	5 years	Vomiting, large quantities. Difficulty most with fluids. Myocarditis	Wasted
15	M. K.	1923	F	31	3 years	Regurgitation. Difficulty with fluids	Wasted
16	T. S.	1924	M	64	3 years	Pain after food. Vomiting. Difficulty especially with fluids	Wasted

6 CASES OF CARDIOSPASM.

X-RAY EXAMINATION	DILATATION	TREATMENT	PROGRESS
Characteristic	Bougies failed	Digital dilatation	Temporary relief from bougies. Later dilatation. No further symptoms. Cured.
Typical	Dilated, but no relief	Digital dilatation	Quite well for 4 years, then lost sight of.
—	Bougies could not be passed	Digital dilatation	Rapid recovery. Able to swallow all foods. Has remained free of all symptoms.
Typical	Failed	Digital dilatation, 2 fingers only	Did well. Occasionally had to pass bougie. Died suddenly 5 years after operation.
Dilatation. Spasmodic contractions	Dilated	Dilated with bougies	Died 6 years later, sarcoma. No recurrence of symptoms.
Much dilatation, over 1 pint	Failed	Digital dilatation	Cured. Perfectly well 6 years after operation.
—	Failed	Digital dilatation	Cured. Quite free of all symptoms 5 years after operation. Skiagram 8 months after still showed dilatation.
Suggested carcinoma	—	Thoracotomy. Later digital dilatation	Cured. Quite free from all symptoms. Able to eat anything 4 years after operation
Slight dilatation only	Passed	Dilated with bougies	Cured. Last note June 6, 1924: quite well, free of all symptoms.
Characteristic	Passed. No relief	Digital dilatation	Rapid recovery. No return of symptoms. Fourteen months later died of cerebrospinal fever.
Characteristic	Passed. No relief	Digital dilatation	Rapid recovery. Cured. Able to swallow anything. X rays 6 months later showed rapid passage, but probably dilatation.
Characteristic	Failed	Digital dilatation	Rapid recovery. Quite well and free from all symptoms 3 years later.
Characteristic	Failed	Digital dilatation	Rapid recovery. Went to S. Africa; at present in perfect health.
Characteristic	Failed	Digital dilatation	Died of cardiac failure 7 days after operation.
Characteristic	Failed	Digital dilatation	Rapid recovery. Able to swallow anything.
Characteristic	Failed	Digital dilatation	Good recovery. Able to swallow anything at present date. X rays 1 month after operation showed the meal passing easily.

introduced the wound was closed and the patient made a rapid recovery. A fortnight later he was able to take all food and fluids well, and an X-ray taken a month later (*Fig. 453*) showed the rapid passage of food from the œsophagus, so that it was necessary to take the film while the food was being swallowed. In this way some collection was still seen at the lower end of the œsophagus. In the upper part there were apparently peristaltic waves and the meal was rapidly passed into the stomach. He is still able to swallow well, but the interval since operation is as yet too short to say that he is completely cured.



FIG. 453.—*Case 16.* Appearance of œsophagus one month after operation.

The above method of treatment, although of considerable severity, has a very low mortality. It will be seen from my own series that there was only one death. This took place in a patient who was 66 years old and who was much weakened and exhausted by his obstruction, which had been present for four years. In addition he had severe auricular fibrillation, the pulse being very weak and erratic; therefore it was only at his urgent

request that I consented to operate. He well recognized the danger of operation, but preferred to run any risk rather than continue longer in his existing condition. The results of treatment in the remainder have been most satisfactory. *Case 4*, which was only dilated enough to take two fingers, had some recurrence which was relieved by the passage of bougies. The others have remained well and free from recurrence. Three patients have died since operation, one of cerebrospinal meningitis, one of sarcoma of the chest, and one suddenly while at work. At the time of their death they were all free from any œsophageal symptoms. The remainder have had no further treatment of any sort and are able to eat and drink anything, a very important point when it is remembered that even with the hydrostatic dilator treatment has often to be repeated at short intervals, so that even if successful in that it allows the patient to eat, it may be extremely irksome.

Apparently the successful results are dependent upon the dilatation being carried to such an extent that the musculature of the lower portion of the œsophagus is paralysed, and therefore in my opinion it is essential that the dilatation be carried out with the fingers. The muscle can be felt to stretch and the amount of dilatation can be controlled so that the danger of injury to the mucosa is reduced to a minimum. If forceps are used, the control is much less and the risk of rupture of the œsophageal walls considerably greater. In some of the reported cases, even when the dilatation was carried out with the fingers, this accident has happened. The margin between sufficient dilatation to prevent recurrence and rupture must be relatively small. The relief from the operation is immediate, and the diet in the after-treatment has only to be limited to the amount required for any operation upon the stomach. There

is, it is true, a danger of peritoneal infection during the operation, not only because the gastric opening has to be made sufficiently large to admit the operator's whole hand, but also owing to the risk that as soon as the œsophagus is dilated below a large quantity of foul fluid from the cavity above may rush down and flood the peritoneum. These dangers can, however, be easily guarded against on the one hand by carefully packing off the stomach before it is opened, and on the other by passing an œsophageal tube as soon as the patient is anæsthetized.

In the treatment of these severe cases many varieties of radical plastic operation have been devised and used, either because dilatation from above has become very irksome or has been found to be impossible by any method. One of the most interesting operations was that reported by Freeman¹⁶ in that it aimed at overcoming the lengthening. A patient was operated upon through a cervical incision, the œsophagus was found to be much dilated and enormously lengthened so that a long loop could be pulled out into the neck. Resection with end-to-end anastomosis was thought to be too risky a procedure; the upper segment was therefore invaginated into the lower after the manner of an intussusception, and sutured in place. An œsophageal tube was passed and the wound sutured. In a few weeks the patient could swallow anything and has remained well for twenty years.

In some cases an attempt has been made by a thoracic operation permanently to diminish the calibre of the œsophagus by plicating its walls after the manner of a gastro- or œœcoplication. The first of these operations appears to have been performed by Reisinger,⁴⁸ and later Meyer³³ reported a case where, after instrumentation and gastrostomy had failed, the thorax was opened and the œsophagus exposed. The vagi were carefully stripped off and the wall of the œsophagus was plicated. The patient developed emphysema, but for a while did well. At the time Meyer thought well of the operation and regarded the good result as in large part due to stripping off the vagi. In a later communication,³⁴ however, he mentions that this patient developed an œsophageal fistula and died a year after operation from suppurative mediastinitis. He reported two other cases. The first could swallow, but had to commence his meals with a large draught of water. The second was not much improved; he was able to swallow fluids but not solids. As with dilatation of the stomach or cæcum, it is not to be expected that this form of treatment would give any measure of permanent relief, although the separation of the vagi and the interference with their action might cause paralysis of the musculature of the lower œsophagus and so lead to a cure. Meyer's results are, however, not sufficiently encouraging to warrant the wider use of so severe an operation.

Most of the other procedures have aimed at permanently overcoming the obstruction by some form of plastic operation on or about the cardiac orifice. An anastomosis between the dilated œsophagus and the stomach was advocated by Biondi³ in 1895. Similar operations were reported by Exner,¹⁵ and Janeway and Green.²⁸ The latter surgeons pointed out that the anastomosis could be performed either above or below the diaphragm.

Lambert³¹ concluded that an operation above the diaphragm was useful for a simple stricture, but for cardiospasm the operation below the diaphragm

was of greater value because it was safer and equally efficient. He reports a case where a flap consisting of the left abdominal wall in its upper part and the lower left thoracic wall were turned up. The diaphragm was then divided between the œsophagus and the inferior vena cava. A loop of the œsophagus was pulled down and sutured to the stomach. A crushing clamp which entered the stomach through a gastrostomy wound was applied to the tissues between the sutures. It was tightened after four days and removed after nine days. This method was followed by a complete cure. He performed the operation only after repeated attempts at dilatation with bougies and Plummer's dilator had failed.

In some cases, instead of a direct anastomosis between the stomach and œsophagus, some form of plastic operation which would lead to a permanent enlargement of the lower end has been attempted. Meyer³⁵ has reported a case in which an operation similar to the Heinicke-Mikulicz pyloroplasty was performed. The recovery was slow but continuous, the patient still being under treatment eight months after the operation.

Heller,²⁰ in 1914, advocated the use of a longitudinal division of the muscular wall down to the mucosa, much after the manner of the Rammstedt operation for congenital pyloric stenosis. His case did well, and seven years later he reported²¹ that the patient was progressing favourably. He states that he knows of 16 such cases with no mortality, the results being good in 12 and poor in 4. A similar operation had apparently been previously performed by Wendel.⁵⁸ Zaaiger⁵⁹ strongly advocates this method for those cases in which dilatation is not possible, and states that he has had 8 cases with no mortality. A case of a similar operation has been reported by Hurst and Rowlands,²⁶ but in this the œsophagus was opened to make sure that all the circular fibres were divided, and probably because of this there was a fistula, which soon healed. The symptoms ceased after the operation, but the patient has not been followed up for sufficiently long to say that he is cured.

Watts⁵⁷ has reported at length a most interesting case with a fifteen years' history, where the passage of bougies and dilatation with two fingers by the Mikulicz method failed to cure. A gastrostomy was performed, but the patient refused to keep this open. She developed pellagra and a radical operation was then performed. The cardia was exposed through the abdomen. a 4-cm. incision was made through the anterior walls of the stomach and œsophagus, and these structures were approximated after the manner of a Finney pyloroplasty. This method was followed by a complete cure.

All these operative measures are unquestionably very severe, and especially is the risk of a thoracic operation too great if any simpler method is available. It is true that the plastic operations which have been reported on that portion of the œsophagus below the diaphragm, and the cardiac end of the stomach, have shown a low mortality rate, but some of these have given unsatisfactory results. Any form of anastomosis involves division of the diaphragm, with the consequent risk of injury to the pleura and possible infection of this cavity or of the mediastinum. Simple division of the circular muscle-fibres after the method of Heller has also been followed by failures, according to Heller in 25 per cent of cases. With digital dilatation the risk would seem to be much less. Apart from my own series, which shows only

one death, and that in a patient who was very seriously ill, one knows that simple opening of the stomach is associated with practically no risk. The only danger is that of rupturing the lower end of the œsophagus, and if the dilatation is slowly and carefully carried out, this should practically never occur. As the mucosa is left intact, there should be very little tendency for any subsequent contraction, and the after-results in my own cases would seem to show that there is a very slight chance of any recurrence, provided the dilatation is carried to a sufficient degree. In the only case of my series in which there was further trouble (*Case 4*), and in the case reported by Watts, where this method failed, the dilatation had only been carried to the extent of inserting two fingers, which was evidently insufficient. When fully dilated, the lower end of the œsophagus, and therefore also the opening in the diaphragm, will admit the cone formed by the four fingers to pass the proximal interphalangeal joint. My own experience therefore leads me strongly to the conclusion that digital dilatation affords the safest and most satisfactory method of treatment for all those cases of cardiospasm in which dilatation with bougies or the hydrostatic dilator is either not possible or affords too small a measure of relief.

An interesting question naturally arises: What happens to the dilatation and hypertrophy of the œsophagus when the obstruction has been removed and the food passes easily? Lambert³⁰ states that the œsophagus which has been greatly dilated in many cases does not regain its muscular tone and cannot return to its normal size and shape. Plummer⁴⁶ says that after operation the œsophagus does regain its shape and size, and that its walls can and do return to normal, an observation which would lead one to believe that many of his cases were of the milder variety or were seen in the earlier stages. I have examined several of my cases at long periods after operation when they have been free from symptoms, and have found it extremely difficult to say what is the condition of the œsophagus, for the opaque meal passes through so rapidly and directly that a complete picture of the outline of the tube cannot be made out. The meal, however, seems to pass over a relatively wide area, which would lead one to infer that although collapsed there is really not any definite diminution in the size of the lumen. This failure of the walls to recover their normal characters after the obstruction has been removed would lend further support to the view that the condition is of congenital origin.

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ABDOMINAL TORSION OF THE OMENTUM.

BY ERNEST COWELL, CROYDON.

DEFINITION.

THE term 'torsion' is thus defined in Quain's *Dictionary of Medicine*: "In relation to organs or growth, it indicates a form of displacement in which the mass is twisted on itself." Some writers use the word 'volvulus' in connection with twisted omentum, but this is misleading and should be kept for a description of twisted bowel (Billing).

INTRODUCTION.

Abdominal torsion of the great omentum, unaaccompanied by complications arising from, or factors associated with, any form of hernia, is a rare condition. A search of the literature from 1882 to the end of 1924 has revealed only eighteen recorded cases, including a new case met with in the surgical practice of the author. In view of the fact that few surgeons publish isolated cases, especially in this country, it is hard to believe the condition is really as rare as one might otherwise suppose. Of the 18 cases, 8 are reported from America, 3 from Germany, 2 from Austria, 2 from France, 1 from Australia, and 2 from England.

Torsion of the great omentum associated with hernia is not uncommon. Considerably over a hundred papers have been published on this subject, and approximately 140 cases described.

A search in some of the larger surgical text-books has shown that in the majority of cases an extremely scanty description of the condition is given, if indeed any at all. Thomson and Miles (6th edition) alone give a short but full account. Keen's *System of Surgery*, 1908, Vol. IV, dismisses the subject in a few words. One German reference is given (Litthauer, 1906, an unimportant paper) together with the English work by Corner and Pinehes, 1905. This reference, however, is given "Corner and Pinehes, date 1805".

HISTORY.

According to Aimes, the first surgeon to describe torsion of the omentum was Pierre de Marchettes, in 1851. I have been unable to trace any publication by this author. To Oberst, in an article on hernia (1882), belongs the credit of first drawing attention to the condition. His case was associated with an inguinal hernia. Until 1902 no case of true intra-abdominal torsion was described. Beyond the mere publication of cases, the most helpful articles dealing with pathology and etiology are those of Seudder, 1904, Corner and Pinehes, 1905, Lejars, 1907, Fuller, 1908, and Aimes, 1919. Hedley, in 1911,

published a short paper dealing with 93 cases, mostly hernial. Smythe, in 1906, gave an elaborate differential diagnosis between the condition and appendicitis.

SURGICAL ANATOMY OF THE GREAT OMENTUM.

The anatomical facts which have a surgical bearing on torsion of the omentum may be described under the following heads: (1) *Developmental abnormalities*; (2) *Size and position*; (3) *Arrangement of blood-vessels*; (4) *Nerve-supply*.

1. **Developmental Abnormalities.**—These abnormalities would appear to be almost unknown. Cullen, in his case, thinks that the torsion occurred in an accessory portion of the omentum. The twisted portion, as in my case, appears so isolated from the rest of the organ that it is tempting to regard the part as accessory, whereas it is in all probability merely an outlying portion. In this connection may be mentioned the 'third omentum' of Bierman. A better term would be 'accessory small omentum' (Fig. 454). This triangular fold hangs down over the right half of the stomach and may produce symptoms simulating chronic gastric ulcer. In Bierman's paper an X-ray picture is given showing a permanent notch in the lesser curvature. The term 'third omentum' is usually applied to a large fatty fold which passes from the cæcum a variable distance along the ileum. I myself have recently encountered a post-mortem specimen of Bierman 'third omentum'. There was no deformity of the stomach, and the condition was not associated with gastric symptoms.

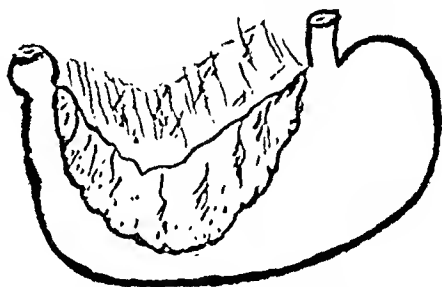


FIG. 454.—Bierman's 'third omentum'.
(Redrawn from *Surg. Gynecol. and Obst.*, 1923, xxxvi, 708.)

2. **Size and Position.**—The size and weight of the great omentum varies within very wide limits according to the general state of obesity of the patient. In stout persons the weight may be several pounds, and in emaciated cases only an ounce or two. Cunningham's *Anatomy*, page 1104, states that the omentum hangs down to a variable extent and that it is rare to find it spread evenly over the front of the intestines; more commonly it is folded in between some of the coils of intestine or tucked into the left hypochondrium. The latter statement is interesting because, when either the whole or a part of the omentum undergoes twisting, symptoms and signs are almost invariably produced on the right side of the abdomen. Lockwood is quoted by Cunningham to the effect that "In bodies under forty-five years of age, the omentum can rarely be drawn down below the level of the pubic spine; in older bodies the reverse is the rule". It will be seen, however, in discussing the etiology later, that in rather more than half the collected cases of pure intra-abdominal torsion the average age was thirty years.

The mobility of the two lateral borders of the omentum varies. The left

border is usually packed into the left hypochondrium, even extending round to the loin, and as a rule presents a straight margin. Lying over the contracted descending colon, it does not undergo the same amount of movement as the right border. The latter usually presents one or more processes (*Fig. 455*), and

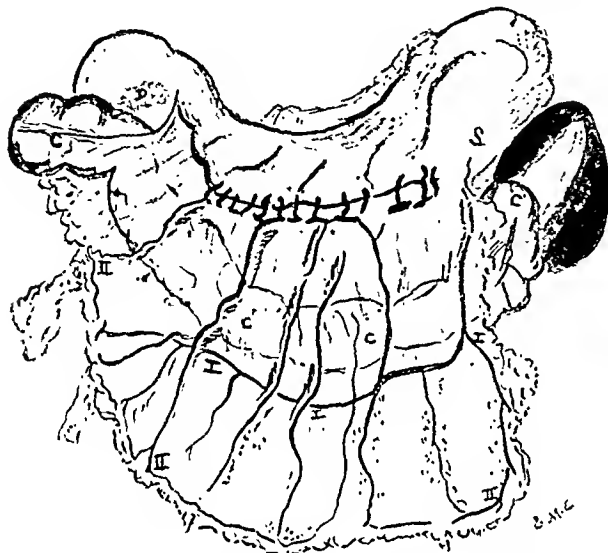


FIG. 455.—Fat-free omentum showing main blood-supply. Two epiploic arteries are seen forming I, Subcolic arch; II, Marginal arch. Five or six epiploic arteries course down over the colon, in small mesenteric folds of their own, to end in the marginal arch. S, Stomach; D, Duodenum; C, Transverse colon. (Sketch by the author from specimen.)

lying, as it does, over the cæcum and ascending colon, undergoes more movement than the left border. Possibly these facts account for the greater frequency of torsion occurring on the right side of the abdomen. The mobility of the omentum depends upon: (a) Diaphragmatic action; (b) Intestinal peristalsis; and (c) Movements of the abdominal wall (Dickenson, and also Aimes).

Some interesting experiments of Ricoux and Milian showed that when irritating particles were introduced into the peritoneum, within fifteen minutes they were found rolled up in the omentum near the stomach. In laparotomies,

on the other hand, I have observed either enlarged glands or tuberculous nodules in an otherwise healthy omentum which have not led to any deviation from the normal position of the organ.

Byron Robinson states that the omentum extends into the pelvis in 25 per cent of males and 50 per cent of females. In my 18 collected cases the sexes are almost equally represented (10 males, 8 females).

Eccles, in writing of the position of the omentum as the result of a study of 90 subjects, says that in only 50 per cent is the organ unfolded.

3. Arrangements of Blood-vessels.—According to Payr the arrangements of the vessels is an important factor in the causation of torsion. If the veins become engorged, the accompanying arteries are pulled on and the elasticity of their coats causes torsion.

Most text-books of anatomy fail to refer in detail to the arrangement of blood-vessels in the omentum. I have examined the omental blood-supply and would draw attention to the plan shown in *Fig. 455*. Here, in a favourable subject, the vessels are easily seen. The main supply is derived from long epiploic branches of the right and left gastro-epiploic arteries. These course downwards over the transverse colon, not between the anterior layers of the omentum, but in little peritoneal folds or mesenteries of their own. Arriving at the lower border of the omentum, the right and left branches eventually

join each other, forming a fine marginal arch. Three or four epiploic branches reach this arch at intervals between these two. The marginal arch also receives a few small branches from the subcolic arch. The subcolic arch lies a variable distance below the transverse colon: it may be 1 inch or as low as 3 or 4 inches. Usually the arch is well formed, but sometimes is difficult to identify. It rises from the first left epiploic artery and runs almost horizontally towards the right, where it is completed by anastomosing with a branch of the second right epiploic artery. The arch is crossed by the intervening epiploic arteries as they continue downwards to end in the marginal arch. The veins run with the arteries. Posteriorly a few branches reach the lower portion of the omentum from the middle colic artery.

4. **Nerve-supply.**—Reference to the text-books of anatomy again shows that very scanty mention is made of the nerve-supply of the omentum. In a fat-free omentum fine branches of the splanchnic nerves may be seen running upwards anteriorly over the colon, uniting with the nerves from the stomach to join the semilunar ganglia. Posteriorly one or two nerves may usually be found running with the colic vessels to join the celiac plexus.

The sensitiveness of the omentum to pain has been studied by Gordon Taylor, Hillman, and others, during surgical operations carried out under regional and splanchnic analgesia. When the celiac and semilunar ganglia are blocked by the method described by Gaston Labat (similar methods also by Kappis and Naegeli), or the splanchnic nerves alone by paravertebral injections from the 6th to the 12th dorsal vertebra (Marc Roussiel), the omentum may be handled or even pulled on without causing any pain in a conscious patient.

Clinically I have observed violent and acute epigastric pain, felt chiefly in the gall-bladder region, which at operation was found to be due to a band of the right part of the omentum being tightly adherent to the fundus of the uterus. Division of this caused complete cessation of symptoms. In the cases where torsion occurs, pain is always felt, and always on the right side of the abdomen.

MORBID ANATOMY AND PATHOGENESIS.

Morbid Anatomy.—Reference to *Figs. 456* to *458* will show the common appearance of this condition. The size of the mass ranges from a large tumour, where the whole omentum is involved, to a small one the 'size of a fig' (Baldwin's case), where a portion only is twisted. The measurements of specimens shown in *Figs. 457* and *459* are those most commonly met with. Out of 11 cases collected by Skeel, the whole omentum was involved in 5, part in 5, and the 'accessory' omentum in 1. The pedicle is usually the size of a finger, and has been found twisted once (Stewart)

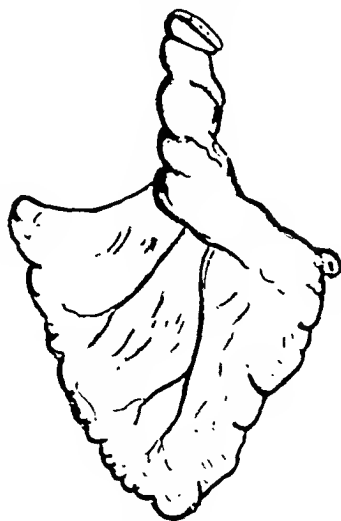


FIG. 456.—Redrawn from Köhler's case. (*Arch. f. klin. Chir.* 1918-19, cxi, 1S, 514.) ($\times \frac{1}{2}$.)

or as many as eight times (Baldwin). As a rule it is impossible to untwist the pedicle. In one case (Eitel) the omentum was 'unrolled', replaced, and the patient recovered. This case is a doubtful one and is not included in my list of true cases.



FIG. 457.—D'Allaine and Rouffiac's case, (Redrawn from *Bull. et Mém. Soc. anat. de Paris*, 1923, xciii, 327.) ($\times \frac{1}{3}$.)

As a result of the strangulation and interference with blood-flow, the mass is generally found in a state of red infarction. The colour is usually described as dark purple, black, or a dark red. On viewing it through the peritoneum some authors have noted a bluish appearance. Many writers emphasize the lightness of the adhesions between omentum, parietal peritoneum, or neighbouring organs. In the author's case the ease with which these fine recent adhesions gave way was remarkable. It must be remembered, however, that in certain cases an old, dense attachment exists to some organ such as the appendix or a Fallopian tube, which requires care in division (*see Fig. 457*). The omental mass is usually found adherent to the anterior parietal peritoneum, this accounting for the physical sign of dullness frequently noted. In my case the blood-vessels of the parietal peritoneum were vividly injected, producing a scarlet appearance.

The consistency of the mass is peculiar, and is well described by Stewart as feeling "like a gauze sponge found in the abdomen".

As a rule operation is performed before necrosis has time to develop into gangrene. In Lefebvre's case, however, the black mass was found friable and on the point of breaking down, having undergone Hartmann's third degree of infarction. Gangrene has been described in hernial cases (Demons and Moresco). In two doubtful cases early diffuse abscess formation was beginning (Swain). The pedicle may rupture and the mass become attached secondarily to some abdominal or pelvic organ (Wiesinger). An important fact to bear in mind is the frequency with which a blood-stained peritoneal exudate is met with, as indeed in all cases of strangulation of an abdominal organ. This varies in amount from a few ounces (Fuller) to one and a half litres (Simon). In the series of cases here described more than half the authors do not mention the question of free fluid. Several of the remaining authors speak of a 'rush' (Corner and Pinches, also Skeel), showing that the fluid is under considerable tension. In some of the specimens removed vascular engorgement is pronounced (*Fig. 458*). In the author's case it was difficult to find any enlarged vessels.



FIG. 458.—Scudder's case, (Redrawn from *Ann. of Surg.*, 1904, 916.) ($\times \frac{1}{3}$.)

A case published by Adams as one of "Primary Acute Inflammation of the Great Omentum" is interesting as a possible pre-torsional state of the

omentum. Here after two days' pain in the right lower abdomen and signs of a mild appendix attack, the omentum was found congested, inflamed, and lightly adherent to a reddened area of parietal peritoneum. The appendix merely showed signs of chronic disease.

A contributory cause should be looked for before the abdomen is closed. The hernial orifices should be examined: even if there is no hernia or if one has been down for many years, fine adhesions may exist in the neighbourhood of the internal abdominal ring (Block). In another case (Picquet) a distant pedicle of twisted omentum was found inserted into the inguinal region, but without any apparent hernial orifice.

Inflammation of the vermiform appendix, either acute or chronic (Schoenholzer), salpingitis (Noble), pressure of an ovarian cyst (Payr), or hydatid cysts (Broca, also Tuffier) are the commonest contributory pathological factors. Other pathological complications that have been met with are described by Aimes in his valuable paper: suppurative pancreatitis, peritonitis, hæmatemesis and melaena, pulmonary embolism, phlebitis, and blood-stained ascites.

Pathogenesis.—The hypotheses put forward are as follows (Aimes):—

Baracz: The presence of a hernia leads to adhesions which eventually result in the twisting of the omentum. In this connection Picquet points out that in many cases a double pedicle becomes formed, between which the omentum swings like a handkerchief folded triangularly.

Richardson: Following inflammation of some organ such as the appendix, the free edge becomes matted. This later forms a ball, allowing easy rotation. There is, however, very little evidence for this.

Jaboulay: The condition results from an exaggeration of the normal movements. This is probably true in many cases, since neither a contributory anatomical cause nor a history of trauma is present.

Bazy: Due to increased intestinal peristalsis.

Payr: Due to the anatomical arrangement of the vessels, when, following venous congestion, the arteries twist spirally.

Skeel: The presence of chronic appendicitis in 8 out of 10 cases collected by himself, leads this author to the view that local omental inflammation with thickening occurs, thus giving rise to subsequent twisting.

Baldwin: Supposes a congenital malformation of the omentum may lead to pedicle formation. No evidence.

CLASSIFICATION.

The clinical classification suggested by Corner and Pinches in 1905 has been adopted by most writers on this subject, either with or without slight modification (Fuller, and others). They divide up cases of torsion of the great omentum as follows:—

1. Abdominal: no hernia exists.
2. Hernial: the twisted omentum lies solely in the sac.
3. Hernial and abdominal: (a) A hernial tumour is present; (b) Hernial sac is empty.

Skeel, in 1907, suggested a more elaborate grouping:—

1. Torsion with hernia: (a) Twisted in the sac; (b) Twisted in sac and abdomen; (c) Adherent to sac, twisted above it.
2. Torsion in abdomen: Hernia existing or having existed, but no present connection.
3. Pure intra-abdominal torsion.

Aimes, in 1919, suggested an even more detailed classification:—

1. Partial: (a) Intra-abdominal; (b) Saccular—sac empty, sac full.
2. Total: (a) Abdominal or omento-volvulus; (b) *En masse*, or intra-abdominal and intra-saccular.
3. Complex: (a) Associated with omental tumours and cysts; (b) Associated with inflammation of appendix, tube, or ovarian cysts; (c) Torsion of inflammatory tumour. He also talks of acute and chronic torsion, primary and secondary.

This classification appears unnecessarily complicated, and I therefore suggest the following:—

1. Abdominal: (a) Primary—no apparent cause present; (b) Secondary—associated disease of abdominal or pelvic organs.
2. Hernial: (a) Intra-saccular; (b) Intra-abdominal; (c) Combined.

ETIOLOGY AND CLINICAL STUDY.

In the present paper the results of a study of 18 cases of pure intra-abdominal torsion of the omentum are alone considered. A few cases where hernia was present, but without apparent causal connection, will be described later.

Age Incidence.—10–20 years=1 case; 20–30=6 cases; 30–40=4 cases; 40–50=3 cases; 50–60=4 cases. The youngest case was 14, the oldest 55.

Sex.—Ten male, eight female.

Obesity.—Mentioned as excessive in three cases.

Trauma.—History absent in all cases.

Associated Inflammatory Disease.—Three cases.

Clinical Picture.—From the study of the cases the following composite description may be taken as typical of the condition: The patient, either male or female, at the period of young middle age and having tendency to stoutness is seized with sudden abdominal pain. The pain is not too severe at the onset, and is generalized in the upper abdomen. Later it becomes emphasized and located to the right abdomen from costal margin to iliac fossa. Vomiting may occur, but is not a feature. The action of the bowels gives no useful information.

In almost all the cases the diagnosis of a mild appendicitis is made, and since the pulse is quiet and temperature rarely above 100°, expectant treatment is adopted. However, the patient does not improve, and usually is seen by a surgeon about the fourth day. On examination the general condition of the patient is not grave, but there is commonly an abdominal aspect. The abdomen is generally slightly distended, does not move well, and shows some rigidity of the right rectus. Percussion is dull anteriorly and in many cases an ill-defined ‘doughy’ mass can be made out. This is

usually taken for an appendix abscess, but reflection will show that the gravity of the patient's condition and the size of the mass are out of proportion to the duration of the illness. Further details of symptoms may be studied in the table of cases included in this article.

DIAGNOSIS AND TREATMENT.

Diagnosis.—A definite clinical picture is produced by this condition, and surgeons who have had experience of more than one case (hernial type) have been able to make a diagnosis in subsequent cases (Rudolf—2 out of 4 cases—Lejars, Morestin, Tietz, Payr). So far, a pure intra-abdominal torsion has not been recognized before operation, but the possibility of a successful pre-operative diagnosis should be borne in mind.

I have made a synopsis of a careful differential diagnosis between omental torsion and appendicitis that has been compiled by Smythe.

OMENTAL TORSION					APPENDICITIS
<i>Age</i>	-	35-55	-	-	15-20
<i>Sex</i>	-	Male	-	-	Male to female, 6:1
<i>Early pain</i>	-	Right iliac fossa,	85 per cent	-	Umbilical
<i>Vomiting</i>	-	Infrequent	-	-	Common
<i>Nausea</i>	-	Absent	-	-	Frequent
<i>Pulse</i>	-	80-100	-	-	Rapidly rising
<i>Temperature</i>	-	99-100°	-	-	100-103°
<i>Tumour</i>	-	Large, suddenly	-	-	Develops slowly
<i>Rigidity</i>	-	Less marked	-	-	Early
<i>Percussion</i>	-	Dull	-	-	Resonant at first
<i>Facies</i>	-	Less anxious	-	-	—

Treatment.—A previous knowledge of the condition will ensure the correct management of the case at the laparotomy. So many surgeons of varying experience venture to operate in cases of acute appendicitis at the present time, that it is possible cases of omental torsion may be missed or overlooked.

The mortality of the 18 collected cases is 5·5, one case dying on the third day from bronchopneumonia in spite of spinal anæsthesia (Lefebvre). In one or two other cases the surgeon was greatly hampered by making a gridiron incision. Since, when operating on a diagnosis of acute appendicitis, the surgeon must be prepared to meet with almost any intra-abdominal condition, the incision chosen should be one which will not only give adequate access to the right iliac fossa, but which may also be readily enlarged either upwards or downwards. A right pararectal incision with displacement of the muscle either inwards or outwards is the ideal one. A rush of blood-stained fluid on opening the abdomen should remind the operator of the possibility of omental torsion. The soft adhesions, the bluish purple of the omental mass, and the ease with which the tumour can be separated from its surroundings, readily lead to its recognition and subsequent removal by ligature of the pedicle.

NOTES ON AUTHOR'S CASE.

H., male, age 48, a short stout man, a joiner, 11 stone 12 lb., was admitted to Croydon General Hospital, on Sept. 12, 1924, complaining of abdominal pain,

felt in the pit of the stomach "alongside of the navel" and later in the right lower abdomen. The pain was of four days' duration and gradually increasing. There had been no vomiting or previous attack. The bowels were open. On examination there was tenderness and some rigidity from the gall-bladder to the right iliac fossa. There was some dullness on percussion. No mass could be felt. Pulse 90, temperature 99°. The case was thought to be one of cholecystitis or appendicitis, or both.



FIG. 459. — Author's case. Drawn from specimen ($12 \times 7 \times 3$ cm.).

OPERATION, Sept. 12.—A right external rectus incision was made with displacement of the muscle inwards. Several ounces of dark blood-stained fluid escaped immediately the peritoneal cavity was opened. The appendix was very slightly inflamed and was removed. On enlarging the incision upwards, a dark-red mass, lightly adherent to the intestines and parietal peritoneum, was found. This was separated easily, and at first was thought to be inflamed omentum wrapped round the gall-bladder. The latter organ, however, was found to be healthy. After gentle manipulation the mass was freed, pulled out of the wound, and found to be a portion of the right side of the omentum, twisted twice on a narrow pedicle. This mass was removed after ligation of the pedicle. No sign of any hernia could be discovered. The abdomen was closed and the patient made an uninterrupted recovery. Before removal it was found impossible to untwist the pedicle.

Examination of the Specimen Removed (Fig. 459).—The piece of omentum measures $12 \times 7 \times 3$ cm. The vessels are not especially noticeable. The omentum fat is seen to be in a state of red infarction. No sign of gangrene or breaking down.

SYNOPSIS OF COLLECTED CASES OF ABDOMINAL TORSION OF THE OMENTUM.

Case 1.—Noble, 1901. A female, age 24, admitted to hospital as a case of subacute appendicitis. Operation on the sixth day revealed a small portion of the omentum twisted on a small pedicle. The appendix was found thickened and an old gonorrhœal tube was also noted. The patient recovered after removal of the strangulated omentum.

Case 2.—Baldwin, 1902. Male, age 47, came under observation for acute pain in right iliac fossa. After four days' observation a diagnosis of subacute appendicitis was made and operation performed. A small mass of omentum "the size of a fig" was found twisted eight times on a long pedicle. This was removed and the patient made a complete recovery.

Case 3.—Syme, 1902. A female, age 51, came under observation because of severe abdominal pain chiefly felt "to the right of the middle line". Pulse 70, temperature 98.4°. A vague swelling could be felt, which remained stationary after repeated examinations. Abdominal hydatid disease was diagnosed and operation

performed on the seventh day. A mass of strangulated omentum was found adherent to the intestines. Recovery followed removal.

Case 4.—Scudder, 1904. Male, age 25, was thought to be suffering from appendicitis. The illness began with generalized abdominal pain which later became localized to the right iliac fossa. He vomited at the onset of the attack. On examination a mass dull to percussion was found. Operation was performed on the seventh day and the specimen shown in Fig. 458 was removed. The appendix was cedematous. Patient made an uneventful recovery.

Case 5.—Stecart, 1904. Male, age 55, acutely ill with severe epigastric pain and vomiting. Pulse 120, temperature 101°. A mass in the iliac fossa was present and was regarded as originating in an inflamed appendix. Operation on the fourth day showed a mass of twisted omentum 6×3 cm., which was removed. The appendix showed slight signs of catarrh. Patient recovered.

Case 6.—Simon, 1905. Male, age 26, was regarded as suffering from a sub-acute appendicitis. He vomited at the onset and complained of right iliac pain. The pulse was 100 and the temperature 100°. An ill-defined swelling in the right abdomen. Operation delayed for ten days. On opening the abdomen $1\frac{1}{2}$ litres of dark fluid escaped, and a mass of dark strangulated omentum $18 \times 10 \times 6$ cm. was removed with its twisted pedicle. Patient recovered.

Case 7.—Corner and Pinches, 1905. Female, age 37, thought to be suffering from an appendix abscess. There was a dull mass in right iliac region. Operation on tenth day revealed dark free fluid in the abdomen and a mass of twisted omentum. There were extensive adhesions to surrounding viscera. Patient recovered after removal of affected mass.

Case 8.—Cullen, 1905. Male, age 47. Diagnosed acute appendicitis. Pulse 100, temperature 101°. A mass was noted before operation. Operation disclosed a twisted portion of the omentum, measuring 14×12 cm. This was removed, and the patient recovered. Cullen regarded the twisted portion as "an accessory omentum".

Case 9.—Riedel, 1905. Female, age 38, was regarded as suffering from appendicitis. Complained of right-sided abdominal pain, increased after micturition. Pulse and temperature normal. A twisted portion of the omentum was found and removed. This was adherent to the uterus and the anterior abdominal wall. Patient recovered.

Case 10.—Riedel, 1905. Female, age 38. Commenced with slight vague abdominal symptoms, chiefly nausea and vomiting. Later, pain developed, chiefly in right upper abdomen. Pulse 102, temperature 37.5° . A diagnosis of appendicitis was made. At the operation the appendix was found to be inflamed, but the chief symptoms were due to a mass of twisted omentum which was adherent to the liver and diaphragm. Patient recovered.

Case 11.—Skeel, 1907. Male, age 21, complained of epigastric pain and vomiting. On examination pulse was found to be 116, temperature 101°. The abdomen was rigid and dull on percussion. At operation on the fourth day a 'rush' of blood-stained fluid escaped from the abdomen and a mass of omentum was removed with a pedicle twisted five times. Patient recovered.

Case 12.—Fuller, 1908. Female, about 50, complained of universal abdominal pain. At operation a large quantity of dark fluid escaped and a mass of twisted omentum was removed. The right Fallopian tube was found thickened and inflamed. Patient recovered.

Case 13.—Kothe, 1908. Male, age 26, diagnosed as acute appendicitis. At operation free fluid was noted in the abdomen and an 'infarcted' portion of the omentum with a twisted pedicle was removed. Appendix was found to be normal. Patient recovered.

Case 14.—Köhler, 1916. Female, age 27, admitted to hospital as a case of acute appendicitis with a pulse of 120 and a temperature of 38° . Operation was performed after several days. Dark fluid escaped when the peritoneum was opened,

and the right half of the omentum was found to have undergone torsion. The appendix was normal. Uneventful recovery followed.

Case 15.—Erdman, 1921. Male, age 14, complained of umbilical pain and vomiting. A mass found on examination, which was thought to be due to an appendix condition. A twisted portion of omentum was found near the gall-bladder. This was removed and the patient recovered.

Case 16.—Lefebvre, 1923. Male, age 55. A supposed case of acute appendicitis. The illness began with severe right-sided abdominal pain with vomiting. The pulse-rate was 130, and the temperature 39.4° . Operation on the second day. A large mass of 'black' omentum with a twisted pedicle was found and removed. Patient died a few days later of pneumonia in spite of spinal analgesia.

Case 17.—D'Allaines and Rouffiac, 1923. Female, age 51, complained of severe abdominal pain of no definite localization. Temperature normal; no vomiting. A mass could be felt in the right iliac fossa. Operation on the eighth day revealed a large twisted omental mass $12 \times 7 \times 3$ cm., together with a large amount of blood-stained serum free in the peritoneal cavity. The right tube showed signs of old inflammation. The mass was removed and the patient recovered.

Case 18.—Cowell, 1924. Male, age 48. Came under observation because of epigastric and right-sided abdominal pain. Pulse 90, temperature 99° . A pre-operative diagnosis of cholecystitis or subacute appendicitis was made. At operation on the fourth day several ounces of blood-stained serum escaped and a mass of omentum $12 \times 7 \times 3$ cm. was found with a twisted pedicle. This was adherent to the anterior parietal peritoneum. The appendix showed slight signs of early catarrh. Patient recovered after removal of the mass.

HERNIAL AND OTHER CASES.

The following cases are briefly quoted as being of interest in the consideration of torsion of the omentum. For various reasons they are not included in the list of true cases :—

Swain describes two cases which closely resemble true torsion, but no mention is made of a twisted pedicle.

Case 1.—Male, age 58. Seized with sudden sharp pain in gall-bladder region. There was tenderness and rigidity of the right rectus, with a temperature of 102° when examined on the fifth day. Five days later at operation a dark-red friable mass with yellowish spots, adherent to parietes, liver, and adjacent intestines, was removed. The mass measured $6 \times 3 \times 2$ in. and consisted of matted omentum.

Case 2.—Female, age 25. Abdominal pain increased until the fourth day. The temperature was 102° . No vomiting. A tender lump the size of a walnut could be felt. At operation a specimen similar to that in *Case 1* was removed.

In three other cases the omentum was described as 'rolled up'. This is distinct from torsion and the cases have therefore been omitted.

Eitel's case. This is included by some authors as a true case.

A man, age 44, after repeated tappings for ascites, was discovered to have a large abdominal tumour. At operation this was found to be a mass of rolled up omentum. It was untwisted and the patient recovered.

Peck describes a case where the whole omentum was rolled up in a vertical direction, filling the abdomen from the right side of the umbilicus to the pelvis. The patient, a female, was operated upon on the fourth day and ovarian adhesions were found. She presented a small reducible right inguinal hernia which had been noticed for twelve years.

Two cases were associated with ovarian cysts (Payr and Simons). Cases have also been described by Peck, Wiener, Baracz, Hochenegg and Riedel in which an empty hernial sac existed, but the hernia had not been down for years.

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In Tuffier's case the patient was mentioned as being a large fat man.

—*Smythe's* case is included by some authors, but has been excluded from this series because of the association with hernia. The patient, a man, age 30, weighing 155 lb., and 5 ft. 5 in. in height, had worn a truss for ten years and experienced two attacks of appendicitis. He was seized with sudden right lower abdominal pain. The pulse was 88 to 100, and the temperature 100°. On examination a large tumour was discovered, the size of which was out of proportion to the duration of appendix symptoms. On laparotomy being done a large quantity of coloured serum escaped, and a 'high black mass' was found extending from the pelvis and confined to the right abdomen. This consisted of omentum completely strangulated and almost ready to break down. The mass was untwisted, tied off, and on removal found to consist of the right half of the omentum. There was no connection with the hernial sac, which was left-sided and empty. The specimen showed six twists of the pedicle and measured 10 × 12 in.

Riedel describes a case where an empty femoral hernia existed without apparent relation to the omental torsion. This is the only case in the literature where the co-existing hernia was femoral.

Hotchkiss's case occurred a few days after a large hernial mass had been reduced. At operation the ring was found to be free, and a large black mass weighing five to six pounds was removed. Blood-stained serum was found free in the peritoneum, and the ease with which the adhesions could be broken down was noted.

Grant records an interesting case. A man, age 28, weighing 200 lb., was operated on after two days' pain. An unusual elastic lobulated mass intimately adherent to the ileum by a broad base was removed, and found to be omentum completely isolated from the rest of the organs. Two pints of bloody serum were removed from the pelvis. As a child the man had a right inguinal hernia.

Picquet's case was similar. A robust man, age 64, had noticed pains in the left iliac fossa for some months. The pain radiated up to the epigastrium and was relieved by rest. On examination a mass was found in the left iliac fossa. Six days later at operation a flood of blackish liquid escaped, and a tumour was easily shelled out after separating soft adhesions. Below, the mass was inserted into the inguinal region by a fine twisted cord, and above, a pedicle the size of the index finger was found twisted several times. No hernial orifice could be found.

SUMMARY.

1. Torsion of the omentum is commonly associated with the presence of hernia.

2. True intra-abdominal torsion, however, does exist, though it is rare; the present series consisting of only eighteen cases.

3. The following simple classification of torsion of the omentum is suggested by the author: *Abdominal*: (a) Primary, with no apparent cause present; (b) Secondary, associated with disease of an abdominal or pelvic organ. *Hernial*: (a) Intra-saccular; (b) Intra-abdominal; (c) Combined.

4. Clinical recognition is possible and operative treatment successful.

5. The pathogenesis is uncertain, but obesity is a factor in some cases.

6. Torsion of the omentum should be one of the conditions suspected when a rush of blood-stained serum occurs during a laparotomy on an acute or subacute abdomen. The adhesions readily give way and the mass is easily removed by ligaturing the pedicle.

7. The mortality is low, namely, 5.5 per cent, and no complications have occurred in the present series.

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INFECTIONS OF THE ALIMENTARY TRACT.

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INTRODUCTION.

Scope of the Investigation.—The organs of the alimentary tract and their associated glands are subject to a group of diseases, inflammatory in origin, which may be termed the ‘surgical infections’ because, in the present state of our knowledge, their treatment is by operation in all except early cases. These so-called surgical infections are ulcers of the stomach and duodenum, cholecystitis, pancreatitis, and appendicitis. It is proposed in the present paper to review certain factors which appear to be common to the etiology of the diseases of this group, without dwelling upon the special factor which must admittedly also be present in each case, and to discuss the bearing of recent work, including some original experiments, upon the problem. There are several grounds for bringing together these conditions into one group: (1) *They appear to be largely modern diseases*; (2) *They are diseases of civilized life*; (3) *They are due to the action of pyogenic micro-organisms*; (4) *The cause of the bacterial invasion is still in doubt.*

1. THE INFECTIONS OF THE ALIMENTARY TRACT APPEAR TO BE LARGELY MODERN DISEASES.—While these infections have probably been with mankind for a considerable time, they appear only to have become at all common in the last thirty or forty years. In reading through the *Practice of Physic*, published in London by William Salmon in 1716, a work which claims on the title page to contain information “beyond whatever was yet published by any author, ancient or modern, since disease first appeared in the world to this day”, we come across clinical descriptions which suggest that gall-stones, appendicitis, and gastric ulcer were afflictions of that time. Yet the second edition of Heath’s *Dictionary of Practical Surgery*, published in 1887, does not mention infections of the stomach, duodenum, or pancreas, and only refers briefly to gall-stones from the point of view of treatment. The tenth edition of Erichsen’s *Surgery*, 1895, contains no reference to duodenal ulcer or pancreatitis; gastric ulcer and gall-stones receive only brief mention, and inflammations of the appendix and cæcum are grouped together as typhlitis. In treatises on medicine of this period, gastric ulcer and gall-stones are allotted a much smaller proportion of space than in any text-book of the present time. Thus the second edition of Aitken’s *Medicine*, a work of nearly 2000 pages, published in 1853, contains no mention of gall-stones, pancreatitis, or appendicitis, and only two pages on gastric ulcer; the 1910 edition of Osler’s *Medicine*, out of half that number of pages, devotes eight to gall-stones, nine to gastric ulcer, four to pancreatitis, and seven to appendicitis. Rendle Short.¹ in his article on the causation of appendicitis, states that the disease was rare in

this and other countries until the end of the nineteenth century, and did not become frequent until after 1895.

It would be unfair to lay too great stress on this argument, for it is certain that once a disease has been accurately described and investigated, cases of that disease are subsequently reported in larger numbers than could be accounted for by a sudden increase in its incidence. For example, the diagnosis of so common a condition as duodenal ulcer was rarely made, either clinically or at post-mortem, before the picture of the symptoms was outlined and brought before the profession by Sir Berkeley Moynihan. In earlier writings, only those cases which gave rise to hæmorrhage or perforation were recognized. Similarly cases of pseudo-coxalgia occur to-day in the practice of every surgeon, while five years ago such cases were classed with tuberculous disease of the hip. It is difficult to believe, however, that such marked catastrophes as acute hæmorrhagic pancreatitis, suppurative appendicitis, and gall-stone colic would have escaped the attention of the trained clinical observers of two generations ago,* if their incidence had been in any way comparable with that of to-day.

2. THEY ARE DISEASES OF CIVILIZED LIFE.—These diseases have also in common the fact that they appear to be, in some way, the products of civilized life. With Europeans they are commoner in those whose civilization is highly developed, and in these races have a higher incidence among city dwellers than among the agricultural population. They are found in domestic animals and in wild animals in captivity, but in the primitive races of mankind and among wild animals in their natural surroundings they are almost unknown. I need only refer to the experiences of Colonel McCarrison² in Northern India, of Grenfell in Labrador, and of Fouché³ among the native races of South Africa, for the confirmation of this statement.†

3. THEY ARE DUE TO THE ACTION OF PYOGENIC MICRO-ORGANISMS.—The third reason that I would give for grouping these conditions together, that they are alimentary infections whose primary cause is an invasion by pyogenic bacteria—staphylococci, organisms of the coli group, but most commonly streptococci—is one which may provoke some disagreement, at any rate with regard to the gall-bladder and pancreas. I am well aware of the biochemical view of gall-stones propounded by Chauffard⁴ and his collaborators of the French school, and of the mechanical theory of the causation of pancreatitis associated with the name of Archibald.⁵ I believe that most surgeons, while admitting the great increase in the cholesterol content of the blood which occurs in pregnancy and in certain fevers, hold that this is only a contributory factor in the pathology of cholelithiasis, and that, except in the presence of an infected gall-bladder, cholesterinæmia rarely leads to stone formation. In a series of cases which have been recently examined by Campbell at Guy's Hospital,⁶ the amount of cholesterol in the blood was within normal limits in 10 cases of gall-stones where diagnosis was

* Richard Bright described acute appendicitis in 1839. (*Elements of the Practice of Medicine*, BRIGHT and ADDISON.)

† See recently DOLBEY and MOORO, *Lancet*, 1924, i, 589.

verified by operation, and in 12 cases of suspected gall-stones and cholecystitis. The recent work of Boyd⁷ allows Chauffard's figures demonstrating intra-epithelial collections in the gall-bladder wall to be explained on the view, not of excessive secretion, but of insufficient absorption on the part of a gall-bladder whose wall has been damaged by infection. The figures facing page 60 in Chauffard's well-known book are almost identical with *Figs. 278 and 283* in Boyd's article in the *BRITISH JOURNAL OF SURGERY*. In every one of 52 gall-bladders which contained these intramural collections of cholesterol ester, Boyd found evidence of inflammation. With regard to pancreatitis, the recent work of Mann and Judd⁸ has rendered the mechanical view untenable, while Deaver has established the infective nature of acute and chronic pancreatitis on a sound clinical basis. The primary bacterial origin of appendicitis is more generally accepted, the older view which postulated a preceding injury by foreign bodies in the lumen being no longer held. Whether the infection is commonly hæmatogenous, as believed by many German workers, or from the lumen, is for the present immaterial.

Perhaps more work has been done on the etiology of gastric ulcer than on any disease of this group, and while many conditions have proved to be capable of producing experimental ulcers, the general conclusions at which most observers have arrived have been recently summed up by Stewart.^{9,10} "It is now generally believed", he says, "on strong clinical and pathological evidence, that all chronic gastric ulcers arise in and from acute ulcers". And later, "Bacterial infection and intoxication is undoubtedly the most important direct cause of acute gastric and duodenal ulcer in man, as it is the method by which some of the most remarkable experimental results have been obtained". It is not my intention to analyse these results; but, of recent experimental work, the most interesting is probably that of Rosenow, referred to by Hurst and Stewart. Rosenow's experiments, which have appeared in a series of papers during the last ten years, lead him to the view—to quote the last sentence of a paper in *Surgery, Gynecology and Obstetrics*, of 1921¹¹—that "the conclusion that streptococci are the chief cause of ulcer of the stomach, of cholecystitis, and probably pancreatitis, seems justified".

4. THE CAUSE OF THIS BACTERIAL INVASION IS STILL IN DOUBT.—If we may provisionally accept the view that these infections of the alimentary tract are in some way bound up with civilized life, and that they are essentially due to an invasion by pyogenic bacteria of which streptococci are the most important, we nevertheless find considerable difficulty in tracing the source of these bacteria and accounting for their portage to the site of disease. The researches of Rosenow,¹² referred to above, appear to point to a hæmatogenous infection in each case. He produced experimental gastric and duodenal ulcers in animals by the intravenous inoculation of streptococci isolated from the teeth, tonsils, appendix, gall-bladder, and from gastric ulcers, in human subjects. Certain strains of streptococci appeared to show a tendency to produce lesions in special organs, a characteristic which Rosenow calls 'elective localization'. Thus streptococci from a gastric ulcer, on intravenous injection in animals, produced 68 per cent of lesions in the stomach and duodenum, 21 per cent in the gall-bladder, only 1 per cent in the appendix: those grown from a human gall-bladder produced cholecystitis in 80 per cent

of animals, gastric lesions in 29 per cent; streptococci from the appendix produced lesions in the appendix in 70 per cent, in the stomach and duodenum in 11 per cent, in the gall-bladder in 1 per cent. An interrelation between infective processes in different parts of the alimentary tract is clearly pointed out by these and other experiments, as well as by clinical experience: but it is difficult to be certain whether, in the case of the human subject, these widely-separated lesions should be regarded in the light of cause and effect, or whether they are both, simultaneously or successively, infected from some other source. We are still in doubt as to the true cause of the original bacterial invasion of the body.

In spite of this lack of knowledge concerning the means by which the primary focus has become infected, much attention has been given of late to tracing the paths by which infection may be carried from one portion of the alimentary tract to another, and the route on which surgeons have largely focused their attention is that of the lymphatic channels. The work of many authorities, notably Mangeret, Franke, Pfeiffer, and Bartels, has been collected by Deaver¹³ in his investigations of the lymphatic route by which the pancreas may become infected, his conclusion being that "chronic pancreatitis is a retroperitoneal infection secondary to the more common forms of abdominal inflammation of the duodenum, the gall-bladder, the pylorus, the appendix, and of other parts of the alimentary tract, all of which are connected by a retroperitoneal chain of lymphatics". Judd quotes the work of Graham¹⁴ and Sudler¹⁵ on the connection between the lymphatics of the liver and gall-bladder in support of the view that cholecystitis may in some instances be secondary to a hepatitis. Braithwaite,¹⁶ as the result of the study of the lymph-flow from the ileocaecal angle, has recently suggested that a chronically infected appendix may give rise to ulcers of the stomach and duodenum by a retrograde flow along the lymphatic channels going from these viscera to the collecting glands round the commencement of the superior mesenteric artery.

While these investigations are extremely suggestive, it is very questionable whether the majority of them have any real bearing upon the paths by which infection is actually carried from one organ to another in the body. An examination of the lymphatic channels in a living animal brings out two most striking characteristics: first, the great variation in size which they undergo at different times—the thoracic duct, for instance, in the cat, is at one time almost invisible, at another swollen to a diameter of 4 mm.; and secondly, the extremely leisurely character of the lymph-flow. We have no direct estimation of the pressure in these vessels, but by comparing the conditions present with those in the veins, we are forced to the conclusion that it is very low indeed. The pressure in the smaller veins is from 7 to 15 mm. of mercury. Pressure in a vessel depends upon three factors: the force of the flow, the peripheral resistance, and the resistance of the walls. Compared with that in the veins, the flow in the lymphatics is small indeed; the rate in the thoracic duct of the dog is 4 mm. per second, compared with 85 mm. in the mesenteric vein. The peripheral resistance is almost negligible, owing to the wide character and great distensibility of the channels into which they flow. The walls resemble in structure those of veins, but are very much more

slender. The pressure in the lymphatic channels cannot therefore be more than 1 or 2 mm. of mercury.

Now the method by which these connections have been traced is the injection under pressure of dye solutions into the lymphatic spaces of the tissues. Braithwaite used indigo-carmin solution at a pressure of 6 to 8 mm. of mercury, "the pressure being increased where obstruction to the flow was observed". The effect of injecting a solution into a system of vessels at a pressure considerably higher than that normally obtaining in them will be that the whole system is filled to the limit of its capacity, and the solution follows all paths that are open to it, without any relation to the flow occurring under normal or even possible conditions in the living tissues. If a dye is injected into the lacteals of the cat, it does not follow the normal path of the lymph-flow through the collecting glands to the thoracic duct, but takes an apparently haphazard path along collateral channels.

Then again, the use of a soluble dye ignores the fundamental fact that bacteria in the lymph-stream are carried, not in suspension in the fluid, but in the substance of the wandering cells, whose movements are governed by vital and not by mechanical laws.

The evidence, then, by which it has been sought to prove the carriage of infection from one organ in the alimentary tract to another by means of lymphatic channels is, except perhaps in the case of the pancreas, inconclusive. The arguments which may be adduced from the spread of tuberculous or cancerous lesions are open to even more obvious objections. Nor is the pathological evidence any more satisfactory. The lymphatics of the alimentary canal occur in two plexuses: one in the submucous coat, and one between the two muscular coats.¹⁷ These do not communicate with each other, but drain independently into a subperitoneal lymphatic plexus. An infection reaching a hollow viscus along the lymphatic channels by retrograde flow should therefore produce its earliest and most marked effects on the peritoneal coat of that organ. This is directly contrary to what we know of the early stages of alimentary infection.

To elucidate the paths by which infection is carried to the alimentary tract, our aim should be to approximate the conditions of our experiments as nearly as possible to those actually obtaining in the living body.

INVESTIGATIONS INTO THE PHYSIOLOGY AND BACTERIOLOGY OF THE ALIMENTARY TRACT.

Surgery to-day looks to the study and recognition of disease in its early stages for its abolition to-morrow. Moynihan has coined that invaluable phrase, 'the pathology of the living', to describe the study of morbid conditions in the living subject, which, in his hands and those of other surgeons, has done so much to supplement and advance the knowledge already acquired by post-mortem pathology. In the case of the alimentary tract, this has gone hand-in-hand with a new anatomy and physiology of the living whose inception dates from the pioneer work of Cannon¹⁸ and Hurst¹⁹ on the position and movements of the viscera in normal animals and men, and of Ryle, Bennett,²⁰ and others, who have studied the physiology of gastric secretion and digestion

in healthy individuals by the Rehfuess fractional test meal. Following closely upon this has come the application by Meltzer²¹ and Lyon²² of the Einhorn tube to the study of the conditions obtaining in the duodenum and biliary passages in the living.

At Dr. Hurst's suggestion, I commenced early in 1922 a series of investigations on the microscopical and cultural characters of the duodenal contents and of the bile in cases of gall-stone disease, using the duodenal tube by Lyon's method. I shall not refer to this work in the present communication, but very early it became evident to me that in order to appraise the results obtained at their true value, it was necessary to have a normal standard with which to compare them. The six dressers with whom I was then working very kindly volunteered as subjects, and in them I investigated the characters of the resting gastric juice, and the microscopical, chemical, and cultural characters of the duodenal contents, and of the bile recovered after irrigating the ampulla of Vater with magnesium sulphate.* The results, in so far as they concern the present investigations, are shown in *Table I*.

Table I.—RESULTS OBTAINED FROM SIX NORMAL STUDENTS.

INITIALS	RESTING GASTRIC JUICE		DUODENAL CONTENTS		BILE
	Free HCl	Total Acid	Microscope	Culture	Culture
R. B. F.	26	40	Many leucocytes	Sterile	Sterile
J. A. C.	22	32	Few leucocytes	<i>Str. longus</i>	Sterile
G. T. H.	42 Had drunk	47 water	0	<i>Str. longus</i>	Sterile
H. C. C. T.	0	16	0	<i>Str. longus</i> <i>Sta. albus</i>	Sterile
L. H.	0	?	Many leucocytes	Hæmolytic streptococcus Enterococcus	Sterile
A. T.	Not	done	0	<i>Str. longus</i> <i>B. proteus</i> <i>Sta. aureus</i>	Sterile

In these six apparently normal individuals, the bile was in each case sterile; but the duodenal contents showed the presence of living bacteria in five out of the six, a streptococcus being present in all of the five, and additional organisms in three. In three out of the six, leucocytes could be seen under the microscope in the duodenal contents. Two of the five from whom streptococci were recovered had no free hydrochloric acid in the resting gastric juice.

* The technique employed is described in the Appendix, where also the discrepancy between my results and those of Dr. Hurst is discussed.

Feeling that these results could be criticized on the grounds that the duodenal tube is contaminated during its passage through the fauces. I endeavoured to check them by direct puncture of the duodenum at operation. Cases were chosen in which the operation was for some condition chiefly mechanical in nature, such as adhesions; but, owing to the fact that the healthy duodenum is usually found empty at operation, sufficient material for culture was obtained in only seven cases. The results are shown below.

Table II.—RESULTS OBTAINED FROM SEVEN CASES OF DUODENAL PUNCTURE.

NO.	INITIALS AND AGE				CULTURE
1	A. S.	40	..	..	<i>M. catarrhalis</i> <i>Sta. aureus</i>
2	M. M.	32	..	..	<i>B. coli communis</i> Enterococcus
3	A. H.	40	..	..	<i>Sta. albus</i>
4	E. R.	47	..	..	<i>B. coli communis</i>
5	A. S.	56	..	..	Sterile
6	F. L.	48	..	..	Staphylococcus
7	M. S.	(gastric ulcer)			<i>B. coli communis</i>

It is noteworthy that in these patients—who had all undergone the usual pre-operative starvation—while organisms were recovered from the duodenum in all except one, no streptococci were found. This is in accordance with the observations of Cushing and Livingston,²³ that the intestinal tract, when empty, tends to become amicrobial, and of Knott,²⁸ that the streptococcus is more easily killed by an acid medium than either the staphylococcus or the *B. coli*.

In order to investigate the conditions prevailing in the duodenum over a longer period than I could inflict upon a volunteer, I made investigations upon myself on two occasions over a period of twenty hours. The tube was swallowed one evening, and the next morning its position was verified, and the duodenal contents were withdrawn. Fig. 460 is a reduced sketch from a radiogram taken on one of these occasions. Barium was injected down the duodenal tube with a syringe, and at the same time half a pint of barium

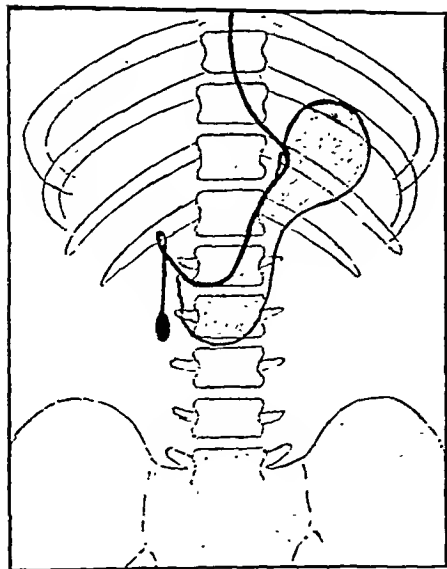


FIG. 460.—Drawn from a radiogram taken during one of the author's personal experiments.

was swallowed to show the outline of the stomach. It can be seen that the metal bulb is opposite the lower part of the 2nd lumbar vertebra—that is, at the junction of the 2nd and 3rd parts of the duodenum. A meal was then taken, and the contents of the duodenum were withdrawn every twenty minutes and examined at once, chemically and microscopically. Slides of the deposit obtained by centrifugalizing the specimens were also dried, and stained and examined later. *Fig. 461* shows the result that was obtained in one of these experiments. (Fuller details are given in the Appendix.)

From these investigations the following facts have become apparent:—

1. The duodenum is empty in the fasting state (in each experiment 1 c.c. was recovered for examination at the commencement with considerable difficulty). It never contains large amounts of material, a sample of 5 to 10 c.c. being obtainable only when the stomach is emptying rapidly. Gastric contents begin to appear in the duodenum within half an hour of a meal entering the stomach, and after a period of two and a half hours the duodenum is once more empty.

2. Leucocytes may be found. These were most marked after the fat meal and the protein meal, and were not found after the carbohydrate meal. (A portion of the slide taken at the point marked X on *Fig. 461* is shown in *Fig. 462*. The majority of the structures shown are certainly not leucocytes, but have rather the appearance of dis-embodied nuclei. Nevertheless two undoubted polymorphs are present, and others are scattered throughout the slide.) Now it is

generally believed that leucocytes leave the surface of the tonsils and return again with ingested bacteria. C. J. Bond²⁴ has proved that white cells leave the surface of a granulating wound, engulf particles of indigo on its surface, and often return again into the circulation. Digby¹⁹ has shown the diapedesis of wandering cells through the epithelial lining of the appendix of the rabbit. It is, then, possible that the emigration and return immigration of leucocytes may take a part in the absorption of a fat meal, since Bradley and Gasser²⁵ have shown that fats may be absorbed without splitting. But it is certainly unwise, in view of the scanty evidence, to lay any great stress on this observation.

3. The contents of the normal duodenum are not often sterile. They may contain various organisms, and often the streptococcus. These do not occur in anything like the number found by Hurst in cases of pernicious anaemia, but they are nevertheless present.

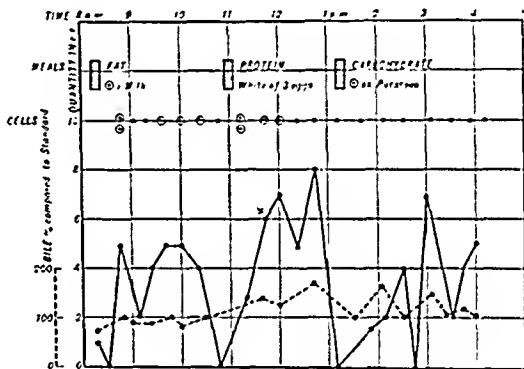


FIG. 461.—Chart showing the result of one of the duodenal experiments. Circles with dots in the centre mean leucocytes; two circles mean abundant leucocytes. A dot only means no leucocytes. The quantity of bile marked on the dotted line is in comparison with an average sample. X Shows the point at which the slide shown in *Fig. 462* was taken.

The Factors governing the Entrance of Streptococci into the Intestinal Tract.—The bacterial flora of the duodenum is to be looked upon as a sample of the freshly arrived visitors to the intestinal tract. Their number and their nature will depend on three factors: (1) The quantity and type of bacteria which are swallowed; (2) The antiseptic power of the gastric juice; (3) The time during which the swallowed bacteria have been exposed to its action.

1. Food contains a great variety of bacteria unless it has been sterilized shortly before ingestion. We are chiefly concerned, however, with streptococci, whose incrimination in a large proportion of alimentary infections appears to be undoubted. Frost and Bachmann²⁶ isolated hæmolytic streptococci from 28 per cent of cultures made from high-grade milk obtained from four different dairies. Biddle, in a personal communication, tells me that of the foodstuffs

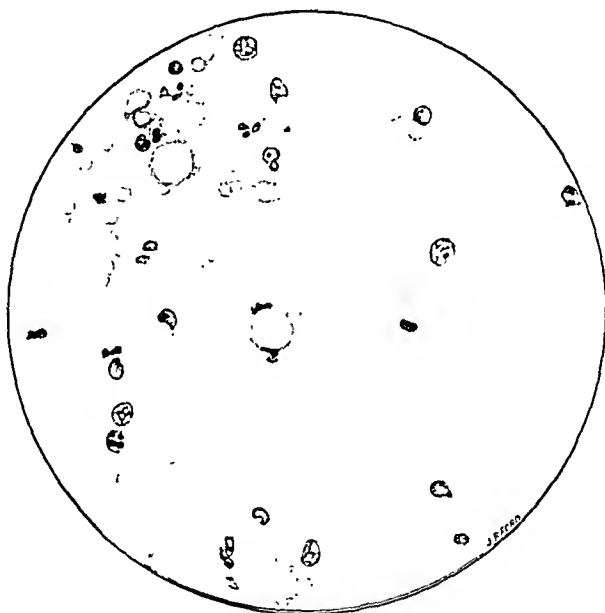


FIG. 462.—Smear of duodenal contents, stained to show the presence of leucocytes. (Compare with Fig. 461.)

examined at the Clinical Research Association, milk, ice-cream, flour, shell-fish, vegetables and fruit in the uncooked state, commonly contain streptococci. Entirely apart from foodstuffs, however, streptococci are found in practically every case of pyorrhœa alveolaris, and a large number of the adult population of all classes suffer from this. The number of chronically infected tonsils is less, but in these too streptococci are found in nearly every case. In infections of the accessory sinuses, the streptococcus is again the predominant organism. Thus a considerable proportion of the population are continually swallowing streptococci, apart altogether from any question of food contamination. The high incidence of foci of infection in the mouth among sufferers from alimentary infections is too well known to need comment.

2. The antiseptic action of the gastric juice has long been recognized.

In 1783. Spallanzani²⁷ called attention to the 'non-putrefaction' of gastric juice. Knott²⁸ has lately made a detailed study of what he calls the 'gastric germicidal barrier', and finds that the antiseptic action is due solely to the presence of the hydrochloric acid. He has divided the more common organisms into four groups, according to the concentration of free hydrochloric acid which they are able to survive for twenty minutes.

- a. Spore-bearing organisms, such as anthrax, easily able to survive 0.3 per cent HCl or more.
- b. Resistant strains of *B. coli*, killed by 0.3 to 0.4 per cent HCl.
- c. Bacilli of the typhoid-dysentery group and staphylococci, killed by 0.15 per cent HCl.
- d. Streptococci, pneumococci, and diphtheria bacilli, killed by 0.02 to 0.03 per cent HCl.

In connection with these figures, it may be recalled that Ryle and Bennett, out of 100 normal young men, found 4 with complete absence of HCl in the gastric juice, even after excluding 3 apparently normal achlorhydriacs who had some history of indigestion. In a series of persons with symptoms, the number is distinctly higher. Thus Hurst²⁹ found that in 325 consecutive test meals at New Lodge Clinic, complete achlorhydria was present in 10.5 per cent, and free HCl was absent from the one-hour fraction in another 9.2 per cent. Bennett and Venables³⁰ have shown that the emotions of fear and nausea may produce temporarily a very marked drop in acid secretion. Campbell³¹ found that in 62 healthy students the free HCl was below 0.03 per cent in 6 (in 3 once, and in 3 on more than one occasion) throughout the meal, and in 10 others it never rose above 0.07 per cent and was below 0.03 per cent through the greater part of the meal. In 25 others it was below 0.15 per cent. Of course these results were obtained under rather unappetizing conditions with a gruel test meal, and in most cases which have been examined a much higher figure was found after a meal containing meat and bread. Bonar³² showed that 49 per cent of people with gall-stones had achlorhydria, while 55 per cent of the cases of chronic appendicitis had either no free acid or marked hypochlorhydria.

3. Knott's figures are based upon an exposure of the organism to the action of hydrochloric acid for twenty minutes. However, I have shown that portions of a meal begin to appear in the duodenum within twenty minutes. Campbell tells me that water taken by the mouth commences to enter the duodenum in thirty seconds: in many people this would contain dental streptococci which had passed the stomach unscathed. According to Cushing, a glass of milk could be recovered from a jejunal fistula within a few minutes of ingestion, with its bacterial flora remaining practically unchanged.

In an isolated experiment on Feb. 1, 1924, I swallowed a sterilized duodenal tube, and one hour later verified its position in the third part of the duodenum by a skiagram; 10 c.c. of sterile water were then injected down the tube, of which 4 c.c. were recovered for culture. A glass of milk, bought from a well-known dairy with branches all over London, was then swallowed, and the duodenal contents were withdrawn every minute for a quarter of an hour. Cultures were taken from the 1-, 5-, and 15-minute specimens. The results of culture are shown in *Table III*.

Table III.—RESULT OF PERSONAL EXPERIMENT.

SPECIMEN	CULTURE
Wash-out from duodenum ..	Sparse colonies of <i>Str. brevis</i>
Milk	Large numbers of <i>B. coli communis</i> , <i>Str. longus</i> . and <i>Str. brevis</i>
Duodenum, 1-min. specimen	Large numbers of <i>B. coli communis</i> *, few <i>Str. brevis</i>
Ditto, 5-min. specimen ..	Large numbers of <i>B. coli communis</i> .* few <i>Str. longus</i> * and <i>brevis</i>
Ditto, ¼-hr. specimen	<div><div><div><div><i>B. coli communis</i>*</div><div><i>Str. longus</i>*</div><div><i>Str. brevis</i></div></div></div><div>}</div><div>All in large numbers, about half that in milk</div></div>

* Organisms which could have only come from the milk.

It can be seen that both *B. coli* and streptococci have come through in large numbers. The next day, Dr. Campbell carried out a gastric analysis on me by the fractional gruel test meal. My secretory curve, as shown in Fig. 463, exhibits a considerable concentration of HCl, being on the border-line between J. R. Bell's classes of average normal and high normal.

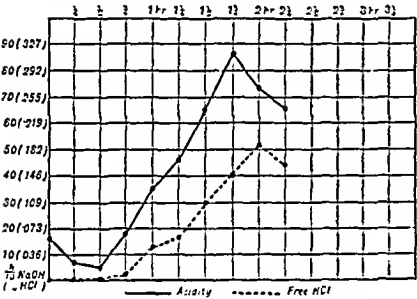


FIG. 463.—Chart showing the result of gastric analysis in author's experiment.

THE EVIDENCE THAT BACTERIA ARE ABSORBED BY THE NORMAL ALIMENTARY TRACT.

The Question of Absorption of Insoluble Particles.—Having shown that, under conditions which cannot be regarded as exceptional, pathogenic bacteria may reach the intestines in considerable numbers, it becomes imperative to determine what are the defences of the intestinal canal against infection, and under what conditions these defences fail. The first question that requires a definite answer is, “Can minute particles of the size of bacteria transverse the intact mucous membrane of the alimentary canal, entirely apart from any question of pathogenicity?” That such particles are carried through the intact epithelium of the respiratory passages is a commonplace.

In 1853, Lister³³ investigated the flow of the lacteal fluid in the mesentery of the mouse. He fed animals on bread and milk mixed with indigo, but was unable to detect any indigo granules in the lacteal fluid. Spencer,³⁴ on the other hand, states that earmine which has been mixed with the food of an

animal passes out through the intact wall of the intestines, but gives no proof of his statement. The general consensus of opinion upholds Lister's view.³⁵

Unaware of these observations at the time, I commenced two years ago a series of feeding experiments, using carmine intimately mixed with the food. Carmine appeared best to fit all requirements. It is entirely innocuous; before starting the experiments, I swallowed 30 gr. a day for a week, and found that it was passed unchanged and produced no perceptible effect. It is insoluble in, and unchanged by, the body fluids, and—almost as important—is not altered by the chemicals used in fixing and embedding tissues for section. In size, the carmine particles closely resemble bacteria. Carmine is taken up by the same channels as, and in similar amounts to, bacteria. If a mixture of carmine and tubercle bacilli is injected into muscular or subcutaneous tissues, the granules and the bacilli are picked up indiscriminately by the same phagocytic cells and carried to the same destination.³⁶ Again, in searching for minute quantities, it is necessary to examine serial sections of the tissues under a high power, and, for satisfactory work, these must be stained with hæmatoxylin. In such a section even single particles of carmine can be picked out, while considerable accumulations of indigo or indian ink may be missed. Finally, carmine cannot possibly be confused with the granules of extraneous or natural pigment which may be found in the body, especially—as shown by Keith³⁷—in the alimentary canal.

In the first experiment, a batch of 12 mice was fed on bread-and-milk mixed with carmine. They ate this readily, so that after a few days the food, the straw, the cage, and the noses and tails of the mice were scarlet, while the fæces were at all times a bright red. When a mouse was killed, the scarlet colour of the carmine showed through the transparent wall of the alimentary canal. Mice were killed after feeding for 3 weeks, 8 weeks, 3 months, 4 months, 7 months, and a year. A careful inspection was made of all the viscera, and pieces of the stomach, small intestine, cæcum, liver, spleen, pancreas, gall-bladder, kidneys, and mesenteric lymph glands were embedded. Serial sections were cut, and every tenth section was placed on a slide, so that when, as was usually the case, 15 sections were examined, this represented a thickness of 150 sections, or about $1\frac{1}{2}$ mm. of tissue. The thyroid gland and lungs were examined in some cases. Altogether some 1100 sections were searched in this way under the high power. I was unable in a single instance to find any evidence whatsoever that carmine granules had been taken up by the alimentary canal and had entered the tissues of the animal.

A second series of mice was started in which, in addition to the carmine, very finely powdered glass was added to the food. Two mice of this series were killed at the end of 3 weeks and 5 months respectively, with exactly the same results. No carmine had been taken up from the alimentary canal, in spite of the enormous quantity that had passed through it. These experiments were, unfortunately, brought to a conclusion owing to the death of the mice when the boy in charge of the animals went on his holiday.

The feeding experiments with cats were conducted on similar lines. Meat and carmine were put together through a mincing machine, so that they were intimately mixed. The cats took this mixture without hesitation, and the fæces were brightly coloured. One cat was fed on this diet only, two were

fed on carmine with a diet deficient in vitamins, one was fed on carmine and powdered glass, and the fifth was given $\frac{1}{160}$ gr. of atropine three times a day in milk, with the object of diminishing secretion, and of producing a certain degree of stasis in the alimentary tract. These experiments are described in the Appendix. The results were exactly the same as in the case of the mice. The rats were killed after six weeks, and sections examined of each portion of the alimentary canal, of the liver, spleen, pancreas, gall-bladder, lymphatics, lungs, and the bone-marrow, but in no instance was there any evidence of carmine having been taken up.

I next set out to determine whether carmine could under any circumstances be taken up from the healthy alimentary canal. Apart from the powdered-glass experiments, I made no intentional investigations on the effect of injury, for it is obvious that, where there is gross damage, foreign matter can enter the blood- and the lymph-stream, and the fact needs no special proof.

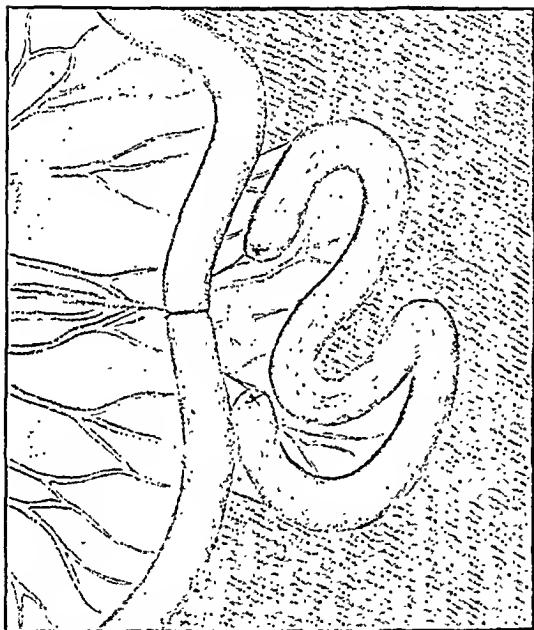


FIG. 464.—To show method of isolating a loop of intestine from alimentary canal, with its blood-supply and lymphatic drainage intact. The loop has been filled with carmine suspension.

My main object was to ascertain the effect of stasis on the absorption of carmine. For this purpose, various portions of the alimentary canal were isolated by proximal and distal ligatures, and carmine was injected into the isolated loop. The continuity of the alimentary canal was restored by joining the portion above and below the isolated loop, either by a lateral anastomosis without division of the gut, or by an end-to-end suture (*Fig. 464*). As a small point in technique I may mention that end-to-end suture in these small viscera is

quite easy if performed over a stick of macaroni. If the macaroni is not boiled, but sterilized in alcohol, it completely dissolves in six hours and leaves a perfect junction. By these means, a condition of localized artificial stasis is produced, lasting as long as the animal is kept alive. I found that if a sufficiently long loop is isolated, if great care is taken not to injure the blood-supply, if the contents of the loop are first emptied, and only a small amount of material is injected so as not to distend the gut, and if the animal is killed within three days, the closed loop remains absolutely normal in appearance, both to the naked eye and on section; there are no signs of toxic absorption, and the animal does not appear to suffer. This experience is entirely in accord with Wilkie's experiments on the closed intestinal loop.³⁸

The effect upon absorption of carmine particles of a condition of stasis—lasting in the longest instance four days, but usually forty-eight hours—was studied in the case of the stomach, duodenum, small intestine, appendix, large intestine, and gall-bladder. In the case of the small intestine and gall-bladder, the results were entirely negative. No evidence of absorption of carmine could be found in the wall of the viscus itself, in the adjacent lymphatics, or in the liver, spleen, and blood. In the stomach some carmine was found in large cells lying in the submucous lymph nodules at the pyloric end. In the appendix, while no carmine was found in the wall, indirect but equally good evidence of absorption was provided by finding one carmine-loaded cell in the ileocaecal gland in one experiment, and three such cells in another, representing in one case about 250 cells in the whole gland, in the other about

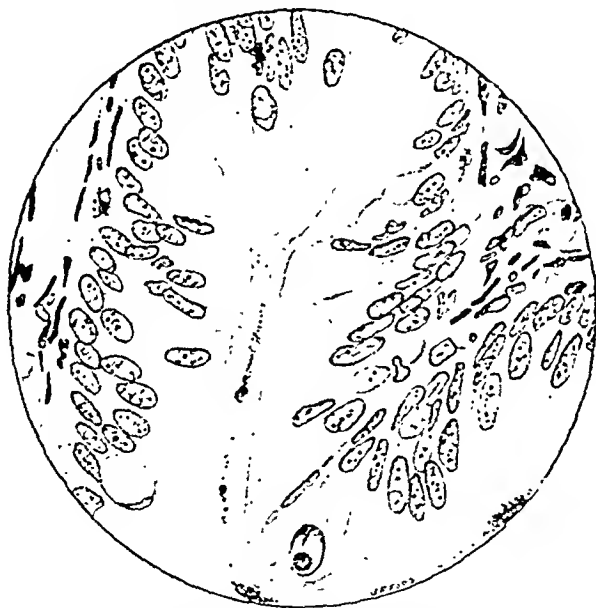


FIG. 465.—From small intestine of frog (oil immersion). Carmine particles can be seen free in lumen of intestine, and also in the substance of two phagocytic cells lying at the base of the epithelial layer.

1500 cells. In the case of the colon, phagocytic cells loaded with carmine were found in the walls of the lymph channels in the mesentery.

I made further experiments with the preparation of colloidal silver used by Bolton³⁹ and Timbrell Fisher⁴⁰ in their work on absorption from the peritoneum and from the knee-joint, but could not obtain any evidence, naked-eye or microscopic, that the silver had been taken up from the ileocaecal angle.

At Professor Keith's suggestion I next investigated the absorption of carmine from occluded loops in the alimentary canal of the frog. Six decerebrated frogs were used. The middle portion of the intestine was isolated by two ligatures, and the occluded loop filled with carmine suspension. The animals were killed after twenty-four hours. In the case of one frog I found

conclusive evidence that carmine had been taken through the epithelium of the alimentary canal, by the agency of the wandering cells. *Fig. 465* shows a portion of the alimentary canal of this frog under the oil immersion. Two cells loaded with carmine particles can be seen lying at the base of the epithelial layer, and abutting on a large lymph channel.

There appears to be a gradual evolution of a defence mechanism on the part of the alimentary canal towards foreign particles as we ascend the scale of the animal kingdom. Unicellular animals, like the amoeba, "prove all things, and hold fast that which is good". In hydra, the cells lining the digestive sac emit pseudopodia, and engulf solid particles. Professor Evans tells me that insoluble particles of food material are commonly found inside the digestive cells of the marine molluscan group. In the sponges, amoeboid

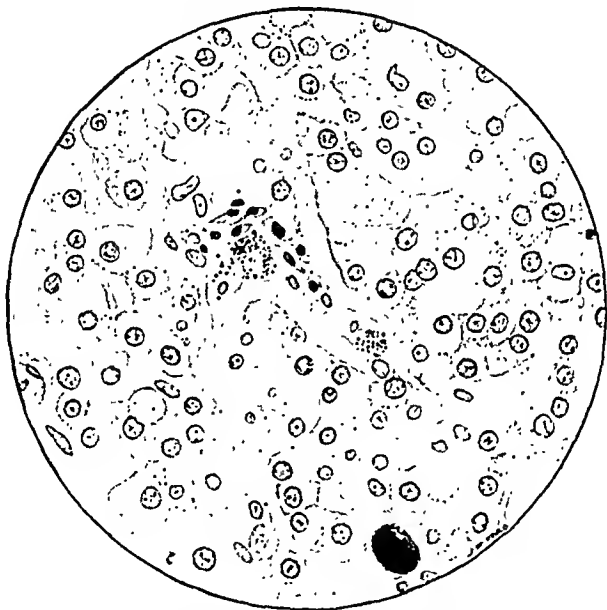


FIG. 466.—Liver of frog (oil immersion). Two cells in the wall of a blood-space contain granules both of carmine and of a brown pigment. A similar cell packed with brown pigment is seen at the lower edge of the field.

cells wander into the gastral cavity, and return again into the organism, carrying solid particles. In the case of the frog, we have seen that under exceptional circumstances carmine particles may be taken up by the wandering cells from the lumen of the gut, and carried into the body. That this taking up of foreign particles is not entirely exceptional in the frog is shown by an examination of the liver (*Fig. 466*). The wandering cells, after taking up carmine from the lumen of the intestine, deposit it in cells lining the blood spaces of the liver, and these cells contain, as well as carmine, large quantities of brown and black granules which have presumably gained entrance from time to time through the walls of the alimentary canal. Pickof⁴¹ has shown that these granules contain no iron. In the mammals, foreign particles in

the food are entirely excluded under normal conditions, but when a state of stasis occurs they may be taken up, the agency being probably exactly the same as in the lower orders—wandering amœbocytes which come between the epithelial cells, especially in the lymphoid areas of the alimentary tube, and, after engulfing the foreign particles, take them by lymphatic channels to the nearest gland.

These wandering cells are known to show a certain chemical intelligence in their dietary. In searching for some inert and recognizable particles which yet would attract them, I tried filling an occluded loop in the cat with an emulsion of tubercle bacilli killed with formalin, and then examined sections of the intestine and the glands stained by the Ziehl-Neelsen method. The result was negative, but two things must be remembered: (1) That the formalin may have rendered the organisms unpalatable to the phagocytes; and (2) That dead bacilli are probably destroyed immediately by the cells that have engulfed them. This experiment, then, may be set aside.

The Absorption of Bacteria.—Finally I used living bacteria. Haemolytic streptococci were chosen, because of the ease with which they can be recognized in culture. In

two experiments, a long ileocaecal loop was excluded, and an emulsion of the cocci injected into it. The animals were killed five hours later. On opening the abdomen the appearance was most striking. In one case the occluded gut was perfectly normal in appearance, in the second the only abnormality was that the appendix and the lymphoid follicles were

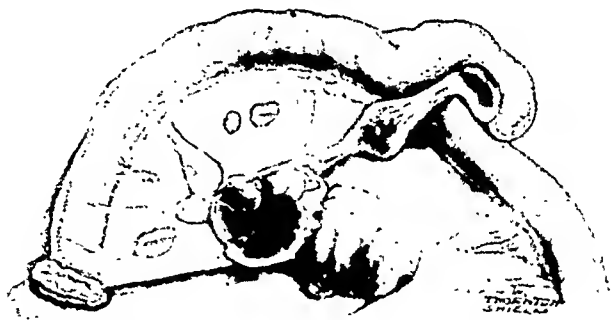


FIG. 467.—The ileocaecal region in Experiment 28 (see Table IV.) Note normal appearance of intestine, in contrast to the hæmorrhagic patches in the lymph glands.

pink in colour (Fig. 467), suggesting that they were the site of an active process. The peritoneal surface was smooth, the canal not distended, and no lesion, microscopic or macroscopic, could be detected in the gut wall. But in both, the nearest group of lymph glands showed bright scarlet patches of subperitoneal hæmorrhage. Cultures were taken from the heart blood, the thoracic duct, the main collecting lymphatic channels, and the mesenteric glands. In the second animal, all cultures were negative; in the first, while blood and gland tissue were sterile, both the thoracic duct and the collecting duct furnished a hæmolytic streptococcus and no other organism. I interpret these results as showing that living streptococci had passed the intact lining of the alimentary canal, and had entered the lymph glands, where they had produced destructive changes in the capillaries, causing the subperitoneal hæmorrhage, but had themselves been killed. In one case, some had passed unscathed through the whole chain of lymph barriers, and arrived in a living condition in the collecting vessels and the thoracic duct.

In two further experiments, streptococci were injected into the lumen of the jejunum in one case, the duodenum in the other, no ligature being applied. The first animal was killed after five hours, and cultures from the thoracic duct and the glands proved sterile, but the same patches of hæmorrhage were found in the first group of glands. In the second animal, killed after three and a half hours, streptococci were grown from the ileal, colonic, and ileocæcal groups of glands, but only in the latter in considerable quantities. These were not proved to be hæmolytic. In the ileocæcal gland stained by Gram's method, some bacteria were found in the lymph spaces, but no cocci. These bacteria had come from the alimentary canal.

In spite of a general belief to the contrary, the evidence that bacteria may be absorbed from the intact alimentary canal appears to me incontestable.

Tubercle bacilli are constantly found in the mesenteric glands of children, though there is no history of a preceding enteritis, and though close inspection fails to reveal evidence of a recent or healed lesion anywhere in the intestinal mucous membrane. Sir Armand Ruffer,⁴² and later Nicholls,⁴³ have demonstrated the constant presence of bacilli in the mesenteric glands of healthy rabbits. Desoubry and Porcher⁴⁴ showed that, during the digestion of fats, many bacteria of all sorts are found in the blood and the chyle. Nicolas and Dercas⁴⁵ fed dogs on fatty soup mixed with tubercle bacilli, and killed them three hours later: the chyle from the thoracic duct was injected into guinea-pigs, and tubercle bacilli were recovered. These experiments have been repeated on many different animals by Ravcncl,⁴⁶ von Behring and Rocmer, Bisanti and Panisset, Ficker, Oberwarth and Rabinowitch,⁴⁷ and bacilli have been obtained in many instances from the blood as well as the chyle, the frequency with which they were found being greater in young animals. Moody and Irons,⁴⁸ feeding dogs on *B. pyocyaneus* and *B. prodigiosus*, were unable to recover the organism from the tissues; but when these two bacilli were injected directly into the duodenum, they were recovered from the thoracic duct in certain cases after one or two hours. Calmette, by killing guinea-pigs, goats, and cattle at different periods after an infected meal, found bacilli in the central lacteal of the villi, lying in the substance of leucocytes.

(It must be mentioned that the absorption of bacteria from the alimentary canal has been denied by Williamson and Brown, working at the Mayo Clinic.)

THE PATH TAKEN BY BACTERIA AFTER ABSORPTION.

It is not unreasonable to suggest, then, that small numbers of bacteria are continually being taken up from the alimentary canal, chiefly at the aggregations of lymphoid tissue, and by the agency of the wandering cells. The majority are either destroyed at once or at the nearest lymph gland. This continual destruction of bacteria in the lymphoid tissues probably plays, as urged by Digby,⁴⁹ an important rôle in the normal defensive mechanism of the body. Herring and MacNaughton state that "the lymph gland is an extremely efficient filter, and only allows solid particles to pass through it when they arrive in too great numbers at a time". Some bacteria, however, do pass this filter unscathed, and escape into the thoracic duct, whence they are carried into the general circulation. Especially does this occur after a

fat meal, not because a greater number of bacteria are taken up, but because so many fat-laden phagocytes are thronging the lymphatic glands that occasional cells slip through these custom-houses of the alimentary canal carrying more sinister luggage. Under conditions of stasis or of injury in the alimentary canal, the number reaching the general circulation is greatly increased. These alimentary bacteriemias have received unconscious recognition for a long time. Poultry breeders starve their birds twenty-four hours before killing them for market, because they find the meat does not decompose so readily. Laboratories only bleed their immunized animals after a fast, to ensure a sterile serum. Ford⁵⁰ obtained organisms of different kinds from 60 per cent of cultures made under the most stringent conditions from the livers and kidneys of healthy dogs, cats, rabbits, and guinea-pigs.

A series of further investigations into the fate of foreign particles after they have left the alimentary canal was carried out, carmine again being used as the indicator.

Absorption of Particles from the Peritoneum.—If one part of the intestinal canal is so acutely affected that the whole thickness of its wall becomes destroyed, organisms will escape into, and be distributed by, the peritoneum. The absorption of small particles from the peritoneum has been fully investigated by Curnow⁵¹ in 1879, by Durham⁵² in 1897, and by Bolton⁵³ in 1921—the last two both giving full reference to the literature. A series of my own experiments on cats has entirely confirmed their findings—namely, that such particles are taken up almost exclusively by the great omentum and by the lymphatics of the diaphragm, whence they are carried to the glands in the anterior mediastinum. It is very striking, after filling the whole abdominal cavity with carmine suspension, to find ten days later that the cavity is clear of the dye, save for the vivid scarlet curtain of the omentum and the staining of the diaphragm, while, on opening the thorax, the anterior mediastinal glands, normally inconspicuous, stand out like deep-red cherries. To the naked eye the walls of the viscera and the mesenteric glands contain no carmine, but microscopic sections show that it has been taken up by large cells in the peritoneum and the glands to a small extent. In no part of the alimentary canal, however, is any evidence to be found that the cells penetrate much beyond the peritoneal coat, and I believe it is quite exceptional for infection to be carried from one abdominal organ to another by this means. In no part of the intestinal canal was carmine found in the deeper muscular, submucous, or mucous coats, however heavily loaded the peritoneum might be. Where the amount of carmine put into the peritoneum is small, it is all incarcerated by the omentum and mediastinal glands. Where a large amount is used, carmine-laden cells get into the general circulation by the thoracic and right lymphatic ducts, and are found in the spleen and to a lesser degree in Kupffer's cells of the liver.

Absorption of Particles by the Portal Stream.—Where the infection is such as to cause local destruction of the mucous membrane, the infecting agent will be carried by the portal blood-stream, as occurs in the case of the typhoid fevers and the dysenteries. Carmine entering the portal blood in moderate quantities is entirely caught up in the liver. If a larger amount is put directly into a portal radicle, carminiferous cells will be found grouped

round the periphery of the hepatic lobules, but some have slipped through, and can be detected in the spleen and lungs. Where a still larger amount is injected, so as to interfere with the circulation of the liver, a considerable proportion will pass through and be distributed by the general circulation, being found chiefly in the spleen, but also in the stomach, intestine, gall-bladder, and kidneys.

Absorption and Carriage of Particles by the Lymph-stream.—

The path with which we are chiefly concerned is that taken by those bacteria which cause no local lesion, but which find their way through the intact wall of the alimentary canal and enter the lymphatic channels. We have seen that they are carried to the lymph glands for destruction, but that they may pass beyond. An infection by the lymphatic route may be imitated

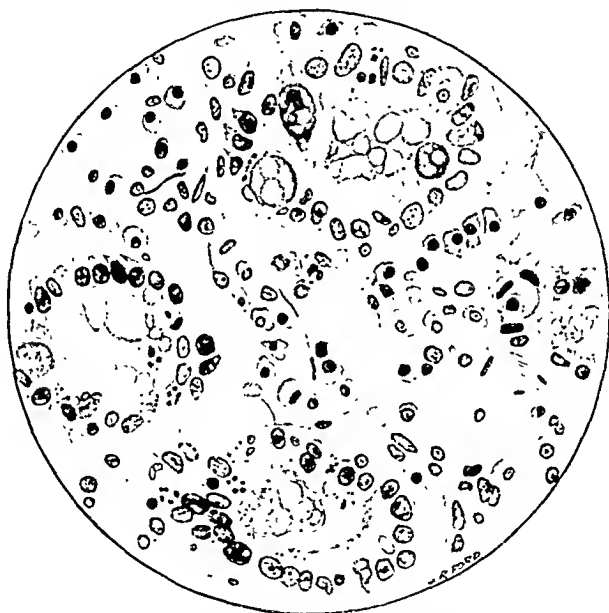


FIG. 468.—Section of duodenum of cat (oil immersion). Carmine had been injected into glands at base of mesentery two days previously. A cell containing carmine granules can be seen lying in a capillary between two tubules.

by injecting carmine directly into the lacteals and the main collecting group of mesenteric glands in the cat. An injection of moderate size is entirely taken up in the gland, and fixed locally; but a large injection is, in part, carried away by cells into the collecting vessels, from them to the thoracic duct, and so to the general circulation. The point on which I wish to lay the greatest stress is, that no evidence can be obtained of direct local carriage of carmine by the lymphatics from one organ to another. Cells, once they have taken up a load, only follow a centripetal path towards the thoracic duct; they never wander along the collateral lymphatics in a reverse direction to the normal flow. After a massive injection into the collecting glands, carmine can be detected in the coats of the stomach, duodenum, small and large

intestine, appendix, and gall-bladder, but none of this has been carried there by lymphatic channels. It lies in the bodies of cells, and these have arrived by the blood-stream. To check this, I injected carmine into the jugular vein of three cats, and discovered that the granules, distributed by the blood-stream, were found in the same situations and in the same relative proportions as the carmine-bearing cells which had, in other experiments, started their career in the mesenteric glands. The carmine is caught up almost entirely in the mucous coats, very little in the peritoneal, hardly at all in the muscular coats. *Fig. 468* is a section from one of these experiments, and illustrates how carmine particles, and therefore bacteria, may reach the different organs of the alimentary tract from a source in one such organ, coming by way of the thoracic duct and the blood-stream.

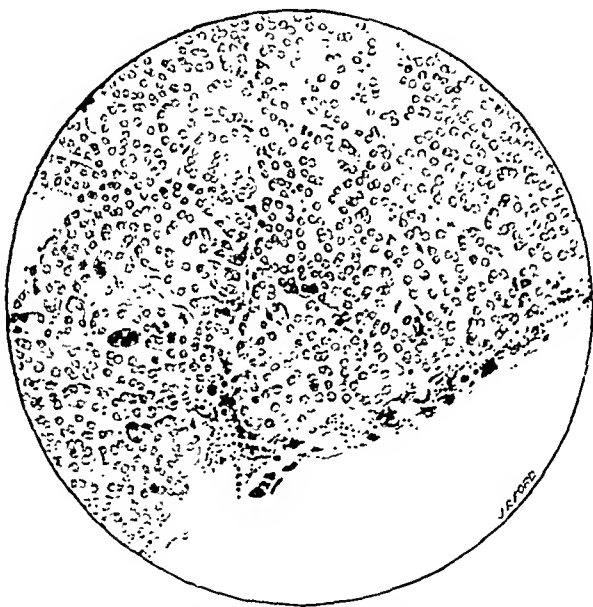


FIG. 469.—Section of pancreas of cat. Carmine suspension had been injected into the peritoneum. Cells carrying carmine granules have found their way along the septa between the pancreatic lobules.

To this generalization there is one exception, the case of the pancreas. The pancreas is slung in the mesentery of the stomach and duodenum; it has no proper capsule, no hilum where its vessels leave and enter, but appears interpolated in the paths of the lymphatics from the upper alimentary organs on their way to the main collecting channels. In the pancreas alone do we find evidence of direct infection from the lymphatics. That the cells come along the lymphatics is shown by a section where the actual process of permeation can be seen (*Fig. 469*). The lymphatic origin of pancreatic infections has been very well demonstrated in the human being by Deaver. Curiously enough, pancreatitis is the commonest of the group of alimentary infections under discussion among wild mammals in captivity. By the

kindness of Dr. Lucas, the Pathologist, I have examined two specimens of acute hæmorrhagic pancreatitis from cercopitheque monkeys which died in the Zoological Gardens last year. The primary lesion in each case was an enteritis, to which captive animals are especially liable.

I may summarize by saying that on each of the routes by which infection from the alimentary canal may be carried, the peritoneum, the portal blood-stream, and the lymph-stream, there is interpolated a defence mechanism whereby bacteria are taken up and destroyed. In the case of the peritoneum, this defence mechanism consists of the great omentum and the mediastinal lymph glands; in the portal blood-stream, it is the phagocytic cells of the liver; in the lymph-stream, the mesenteric glands. Where these mechanisms are overpowered by a mass infection, the organism or particles are in each case distributed by the general circulation. In the case of the lymphatics, the defence mechanism may also be partly outwitted, even in the absence of a massive infection, by the crowd of cells which pass along its channels during digestion.

CONCLUSIONS.

I have endeavoured to advance proof of the following statements:—

Pathogenic bacteria may reach the intestine in a living condition in man, under circumstances by no means exceptional.

Such bacteria may be carried through the intact wall of the alimentary canal and may enter the lymph-stream, and of these a certain proportion will reach the general circulation.

In conditions of stasis in, or of injury to, the alimentary canal, the number of bacteria reaching the blood-stream may be considerably increased. And bacteria, alimentary in origin, may be carried again by the blood-stream to all portions of the alimentary tract, and are specially liable to lodge in the mucous coats of these organs.

I should like now to examine the application of these experimental findings concerning the factors governing alimentary infections to the group of diseases we are discussing.

There are two circumstances which immediately present themselves as distinguishing the life of man under primitive from that under what we are accustomed to call civilized conditions. One is the question of dietary, the other the factor of the rush and stress of modern life.

The Possible Influence of the Modern Dietary upon the Question of Alimentary Infection.—Our average diet to-day differs in two main respects from that of our immediate predecessors, and still more from that of ancient and primitive peoples. One is the high degree of preparation to which our cereals are subjected, the other the smaller and still lessening amount of indigestible material, chiefly cellulose, which we consume.

The refining processes to which the cereals consumed by the Western nations are subjected rob them to a great extent of the important accessory food factors. The effects of such a dietary on the alimentary canal have been investigated by Colonel McCarrison⁵³ in his well-known experiments upon guinea-pigs, pigeons, and monkeys. They are, in the main, a loss of propulsive power, the muscular coats being thinned, atrophied, often transparent; a

profound atrophy of the lymphoid tissues in the bowel wall: and multiple lesions of the mucosa. Thus a deficiency in accessory food factors, alone, will produce the two conditions which favour the entrance of bacteria—stasis and injury—and will damage the mechanism of defence—the lymphoid system.

The absence of indigestible elements in modern foodstuffs removes that insoluble bulk which is the normal stimulant to peristalsis and the factor which ensures that regular evacuation on the part of the lower colon which is perhaps its chief duty. Hurst,⁵¹ in his book on *Constipation and Allied Intestinal Disorders*, states that “fragments of vegetable food, consisting of indigestible cellulose, together with the starch and protein which have escaped digestion owing to their covering of cellulose, are the most important of the articles of diet which mechanically stimulate the intestinal movements”. And later, “in civilized countries the small quantity of indigestible cellulose which is present in the food is generally softened to such an extent by cooking, that it loses much of its value as a mechanical stimulant of intestinal activity.”

England is a highly industrialized island, unable to produce more than a small proportion of the cereals necessary to feed her inhabitants, and largely depending on imported, and therefore highly-concentrated, foodstuffs. Hence constipation is an affliction particularly prevalent among our inhabitants, while lesser degrees of alimentary stasis are probably commoner still. It has been shown that forty-eight hours' experimental stasis will cause the colon of the cat to take up innocuous carmine particles. It seems at any rate probable that the effect upon the absorption of bacteria will be still greater. Such delay will not only favour the multiplication of organisms, but will also conceivably increase that passage through the intestinal walls which probably occurs to some extent under absolutely normal conditions.

The Influence of Modern Social Conditions.—The effect of the stress of modern life is more difficult to analyse, but I am inclined to attribute a more important place in the pathogenesis of alimentary infections to this factor than to that of diet. Professor Lowes Dickinson's hypothetical Chinaman says of our Western civilization, “You have liberated forces you cannot control; you are caught yourselves in your own levers and cogs. You depend on variations of supply and demand which you can neither determine nor anticipate. The failure of a harvest, the modification of a tariff in some remote country, dislocates the industry of millions, thousands of miles away”. The sense of security which comes with possession is denied to all except the fortunate few. Education, without the opportunity to apply the power which it confers in the fulfilment of the creative impulse, leads to a sense of caged ambition. A large proportion of the population are to-day working harder than ever before, dissatisfied with the present, dreading the immediate future.

The possible part played by this continued mental strain, and by the exhaustion which is its logical sequence, in the etiology of the alimentary infections, may be considered under three headings: (1) The effect on the mechanical and motor functions of the alimentary tract; (2) The effect on secretory functions; and (3) The diminished resistance to infection of the body as a whole.

An extremely able article by Blundell Bankart⁵⁵ appeared three years ago, in which he applied Sherrington's experimental work on postural tone in

animals to the problem of the pathology and treatment of the static deformities of orthopædies. Especially valuable is his exposition of the dependence of the reflex mechanism, probably sympathetic, by which this tone is regulated, upon impulses coming from the higher centres, especially from the cerebral cortex. As Bankart says, "the upright figure and the bent figure reflect two very different types of mind. The difference between the attitude of a street loafer and of a trained soldier is not merely physical, it is far more mental". And again, "mental fatigue and inertia leads to deficient postural activity, even though the muscles are well developed and voluntary muscular power is unimpaired". The writer is concerned with the orthopædies of the locomotor apparatus, but his conclusions apply with equal force to the orthopædies of the alimentary canal. Much controversy has centred around the part played in abdominal disease by the abnormal degree of fixity or mobility of different portions of the alimentary canal consequent on variations, be they congenital or acquired, in their peritoneal attachments. But it is undeniable that X-ray examinations in normal individuals, and laparotomies performed for other conditions, reveal these so-called abnormalities in a large number of people who have suffered from none of the symptoms which are said to follow in their train. We are forced to the conclusion that the position of the viscera depends less on peritoneal ligaments or fascial sheaths than upon their retention on the retro-abdominal shelf by the sustained support of the muscles of the abdominal wall, and especially of the obliques. This sustained support depends not on voluntary contraction, but on the continued action of the postural reflex. When this support is lost, the mobile ascending colon and the portions of the canal which are fixed by accessory peritoneal bands do probably suffer in function sooner than those which follow the standard anatomical descriptions. In the presence of a healthy abdominal wall, however, these variations from the average are innocuous, while, where this support is lacking, the most orthodox alimentary canal will in time show signs of giving trouble. This support depends to a great extent upon the condition of the cerebral centres.

The influence of the cerebral centres upon the musculature of the viscera themselves is no less important than that upon the tone of the abdominal wall. Cannon, working with animals, and Barelay,⁵⁶ in the case of the human stomach, have demonstrated that fear and unpleasant emotions are able to cause a cessation of movements, and, in the case of the stomach, a decrease in tone. It is quite possible that the prolongation of such a mental state over lengthy periods would bring about a condition of deficient propulsion in the alimentary canal, and a state of delay or stasis in its contents. I am unaware of any prolonged series of observations on the position and movements of the viscera in the same individual under different mental conditions, but such work would be of great value. Two years ago, while Resident Surgical Officer, I investigated the effect of a week of fatigue on the tone of the stomach in the case of a surgical team of seven members, including myself. The stomach of all the members was radiographed fasting at the same hour and under identical conditions on the first and last days of a very strenuous week of duty. For the week, the average sleep of individuals was between three and four hours per night. The mean position of the pyloric

valve was plotted on both days, and to my surprise was found to be slightly higher at the end of the week than at the beginning. But it is probable that mental depression has a more profound effect upon visceral tone than bodily fatigue, and in this case the prevalent mood at the last examination was one of elation, owing to the end of an interesting week, and the imminence of breakfast after a night spent in the operating theatre.

The recognition of the influence of mental states upon secretion in the alimentary canal dates from Pawlow's observations upon psychic secretion in the stomach. Reference has already been made to the work of Bennett and Venables³⁰ on the effects of temporary mental stress upon gastric secretion. Less is known concerning the control of the activity of the other digestive organs, but that the co-ordination between one and the other is not merely an automatic chemical one is proved by the free pancreatic secretion which is found in many cases of complete achlorhydria. Again, a series of observations in the same subject, conducted over a long period and under different mental conditions, would be of the greatest value. But the evidence, such as it is, suggests that unpleasant emotions tend to the inhibition of digestive ferments, and therefore to a decrease in the bactericidal substances, and an increase in the supply of undigested foodstuffs to act as culture media.

The effect of mental fatigue and depression upon the resistance to bacterial infection is in any case difficult of proof. Such conditions cannot be reproduced in animals, and in man so many sources of error have to be eliminated. Clinical evidence appears to suggest that men doing strenuous intellectual work over long periods succumb more readily than their fellows to microbial invasion, while the course of an established infection appears to be modified favourably or adversely by the mental outlook of the patient.

The Alimentary Sub-infections.—There is thus some support for the belief that the conditions, both of diet and of social régime, under which men exist in the western nations, have a tendency to decrease the defensive mechanisms of the body against the entry of pathogenic bacteria into the alimentary tract, to favour the entry of these organisms from the alimentary tract into the general circulation, and to decrease the natural immunity which should hinder their power to produce destructive lesions in the tissues.

Every medical man must be familiar with a group of cases to which I shall refer as the 'alimentary pseudo-infections', or (hegging the pathology, and borrowing Adam's phraseology) the 'alimentary sub-infections'. In these patients the clinical picture of gall-stones, of appendicitis, of gastric or duodenal ulcer, is mimicked with such accuracy that the absence of an organic lesion can often only be verified by operation. They have certain points in common. There is some underlying worry—a husband out of work, an unhappy home, perhaps the fear of dismissal. There is loss of tone in the abdominal wall, a concavity in the epigastrium, and a sagging forward below the umbilicus. Their gastric analysis shows hyposecretion.⁵⁷ The barium X-ray of their alimentary tract reveals a general laxity and low position of the viscera, sometimes more marked in one portion than another, and a delay in the passage of contents. Constipation is often obstinate and habitual.

In this group of cases which I have tried to define, we have the combination of factors which allows the entrance of bacteria into the alimentary

tract and increases their absorption. The cause of the syndrome I believe to be partly mental and partly dietetic, and a course of treatment based on this hypothesis will relieve the symptoms in all except late cases. But I believe that these 'pseudo-infections' are really true infections of a minor degree. The pain in the appendix and gall-bladder, the dyspepsia, and hæmatemesis are due to a greatly increased entry of bacteria from an alimentary tract whose function is deranged, and their carriage as infective emboli to the mucous membrane of the different organs, just as we have seen carmine to be carried from the mesenteric lymph glands of the cat. Even the teeth, which are so often condemned and executed after scant trial because of their unfortunately accessible position, may in many instances of alimentary infections be the victims and not the criminals. In the majority of cases these emboli produce at their place of lodgement transitory infections only, which are completely effaced by the reparative powers of the tissues where they lodge. Where their virulence or number is greater, or the local conditions more favourable, they cause those destructive and chronic infections which fall into the category of surgical diseases.

If there is any truth in the views advanced, it follows that no surgery of the alimentary tract can afford to neglect the general question of alimentary infection; otherwise even the best planned and most skilfully executed surgical treatment of the local condition cannot promise permanent cure. The search for a satisfactory treatment of gastric ulcer has led to the evolution of one operation after another, each appearing for the time to hold out the promise of cure, until after some years the same tale of recurrences and reinfections commences to be heard. Judd⁵⁸ states that the number of unsatisfactory results is much the same after local excision as after gastro-enterostomy—about 30 per cent in each case.⁵⁹ Partial gastrectomy has not yet been practised long enough to allow a similar comparison to be made; but if bacteria are still being deposited in the mucous membrane, it is difficult to ensure that they shall not repeat their former destruction.

In looking for a source of infection, I would plead for a consideration of the alimentary canal as a whole, its physiology and mechanics, rather than a hasty incrimination of a local lesion which, while often to blame, is in some instances collateral rather than primary. There is an age-long battle of the ileoæcal bridge, commencing in every individual in the first hours of life, when his sterile alimentary canal first becomes invaded by bacteria. In this battle the appendix is one of a group of lymphoid collections engaged in a similar task of fighting infection, but is more liable than the others to succumb because of the ease with which a severe process may occlude its lumen or jeopardize its blood-supply. The appendix becomes tender in the early stages of many intestinal infections, in the first few days of typhoid fever, in many cases of influenza, often after a cold in people who have lost their tonsils. Very often indeed its protective powers have been damaged, and it remains a menace rather than a safeguard; but an appendix which is merely reddened and turgid is often making a powerful fight. While it is not suggested that the removal of an appendix which might have been spared is in itself harmful, it may happen that a deranged condition of the whole alimentary apparatus, the condition in the appendix being but one symptom, passes unnoticed.

Adami⁶⁰ describes the healthy body as potentially, but not actually, sterile. If this is so, asepsis, perhaps in abdominal surgery more than any other, depends not only on the prevention of operative contamination, but on the determination that the bacteria when they come by the blood-stream, as come they will, shall meet with the hostility of tissues undamaged by rough handling or prolonged exposure.

APPENDIX.

INVESTIGATIONS ON DUODENAL CONTENTS IN NORMAL STUDENTS.

MATERIALS.—(1) Duodenal tube of Einhorn type: (2) Rack of labelled test-tubes: (a) Ordinary: (b) Containing sterile broth medium: (3) 20-c.c. Record syringe: (4) Flask of sterile saline solution: (5) Flask of sterile 25 per cent magnesium sulphate solution.

The tube was boiled and kept in sterile water. During swallowing, and between the aspiration of specimens, the free end was protected by a glove finger or a sterile gauze swab. The syringe was kept in a dish containing a mixture of ether and alcohol, and some of this was drawn in and out after each aspiration, the barrel being allowed to dry before use.

METHOD.—No breakfast was taken. The tube was swallowed about 11.0 a.m. as far as mark 2, and a specimen of resting gastric juice withdrawn, which was later examined chemically. The subject then drank a pint of weak tea, and lay on a bed on his right side, with a pillow under the buttocks. After an hour, aspiration was tried, and when typical duodenal contents were withdrawn, about 1 c.c. was put into a sterile broth tube, the rest into an ordinary test-tube for microscopical and chemical investigation. The duodenum was then washed out with sterile saline, using the barrel of the syringe as a funnel, till the contents returned clear. Samples of the last wash-out were again taken in plain and broth tubes. Sixty c.c. of magnesium sulphate solution was then run in through the barrel of the syringe. The subject's head was brought to the side of the bed, and the free end of the tube allowed to hang over, a bowl being on the floor. First the magnesium sulphate was poured out, followed quickly by a flow of bile. Whenever there was a change in the colour of the bile, samples were taken in plain and broth tubes. All tubes were labelled with name, date, and time of sample.

The bacteriological examinations were carried out by Mr. T. S. Keith, Assistant Bacteriologist to Guy's Hospital. The ordinary specimens were examined for reaction, and microscopically for cells and cholesterol crystals. The results are shown in *Table I*.

Cholesterol crystals were found in the bile in the case of Student No. 4 (H. C. C. T.). Recognized by their shape, these crystals also gave a red colour with H_2SO_4 run under the coverslip.

The results shown in *Table I* are markedly different from those obtained by Hurst, who states that "the *Str. longus* is not often found in the contents of the duodenum removed during life with an Einhorn tube, except in Addison's anæmia and in subacute combined degeneration of the cord". The discrepancy is accounted for by the difference in the method used, and the results in each case bear a different interpretation. In my experiments, the duodenal tube was sterilized and then swallowed, every precaution being taken to avoid contamination of the exposed end of the tube. The outside of the tube would probably carry down some bacteria from the fauces, but during its sojourn in the stomach (very rarely less than an hour) it is exposed to the antiseptic action of the gastric juice to a greater extent than the food.

That tube-contamination did not play a part in my results is shown by the sterility of the bile in each case. In Hurst's series, after a sterilized tube was swallowed, the stomach was washed out. Any fluid used to wash out the stomach also washes through the duodenum to some extent. I consider that the bacteria

recovered in my own cases represent those which may be found in a normal duodenum on their way through to the intestines, while in Hurst's series such bacteria would be washed through to the jejunum before the samples were taken, and any organisms recovered represent a flora definitely established in the duodenum of that individual.

INVESTIGATIONS OF DUODENAL CONTENTS OBTAINED AT OPERATION.

In this series, a 10-c.c. Record syringe with a long fine needle was employed. As soon as the abdomen was opened, the duodenum was punctured either in the second part or commencement of the third (according to the position of the hepatic flexure). Some of the contents were aspirated, and injected into a tube of sterile broth. In several cases nothing could be withdrawn, and the amount was always small. The small puncture required no suture.

Some of the punctures were kindly done for me by Mr. R. P. Rowlands and Mr. G. E. Waugh. The bacteriological examinations were done by Mr. F. A. Knott, Bacteriologist to the New Lodge Clinic.

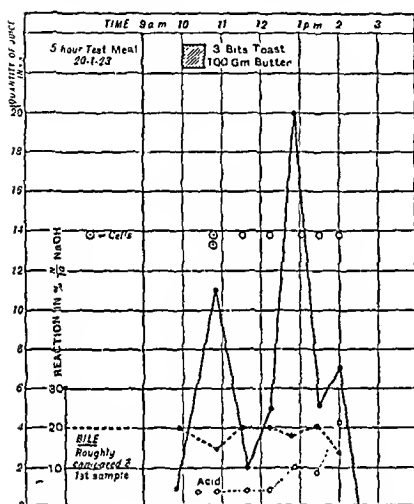


FIG. 470.—Chart giving the result of the second personal experiment.

PERSONAL DUODENAL EXPERIMENTS.

In these two experiments no cultures were taken. The tube was swallowed at 11.0 p.m. as far as mark 4, and fixed to the cheek with strapping. I then slept on my right side, and commenced investigations next morning.

Specimens were withdrawn every twenty minutes where any duodenal contents could be obtained. Reaction was investigated by titrating with $\frac{1}{100}$ NaOH or HCl, the indicator used being phenol red, and the point of neutrality $\text{Ph} = 7.4$. Bile was estimated by comparison of the specimens in a Dubosq colorimeter against a standard representing an average specimen. The colour of this standard was obtained by ox bile, the opacity by soap

solution. Specimens were centrifugalized and the deposit examined at the time under the microscope, a few drops of methylene blue being added. Other samples of the deposit were dried on slides, and later stained with Leishman's reagent and examined.

The results of one experiment have already been discussed; a chart giving the results of the second is here shown (Fig. 470).

ANIMAL EXPERIMENTS.

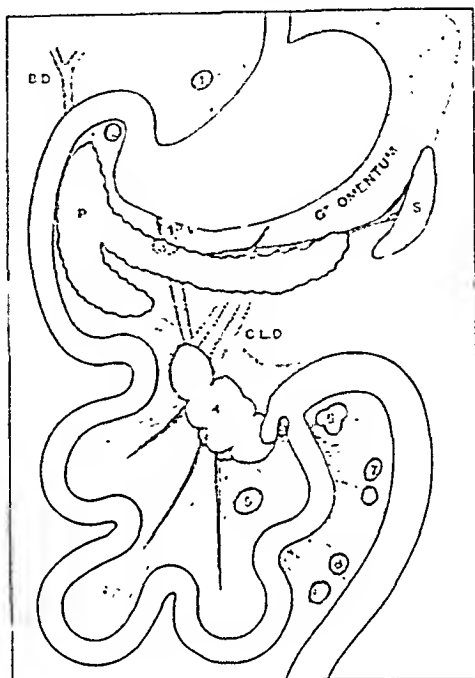
The feeding experiments require no further description. The operative experiments include various procedures carried out with 1 guinea-pig, 28 cats, and 6 frogs. The procedures have already been described in the text, and only a brief summary is appended. The anæsthetic in the case of the mammals was chloroform for the induction, followed by open ether. In two cats, urethane 1.5 grm. per kilo was employed. The frogs were decerebrated.

In the early experiments on cats, it was found extremely difficult to trace any except massive quantities of carmine in the tissues, and the search for the path of spread was accordingly a haphazard one. In the loop experiments, therefore, the following procedure was adopted. After killing the animal, a careful inspection of all the viscera was made. The whole abdominal contents were then removed *en bloc*, including the diaphragm and posterior abdominal muscles. This mass was treated as a whole, dehydrated in six changes of alcohol at intervals of a week, then

cleared in xylol, and finally preserved in liquid paraffin. The advantage of this method was that the organs were thereby rendered partially transparent, so that larger amounts of carmine could be seen: and that all the tissues were preserved, and therefore additional sections could be cut to substantiate or modify the information obtained from the first sections examined. The disadvantage was that the

FIG. 471.—Diagram to illustrate the lymphatic drainage of the alimentary canal in the cat.

1, Gland of lesser omentum: 2, Pyloric gland: 3, Pancreatic gland (on neck of pancreas, at formation of portal vein. Projects mostly into lesser sac): 4, Main group of mesenteric glands (closely related to the duodenojejunal flexure and ileocaecal region): 5, Appendicular gland: 6, Ileocaecal group: 7, Upper colonic group: 8, Lower colonic group: 9, Ileal gland. B.D., Bile-ducts: P, Pancreas: P.V., Portal vein: S, Spleen: C.L.D., Collecting lymphatic ducts (opening into thoracic duct).



fixative only reached the deeper parts of the organs after a considerable amount of autolysis had taken place—a fact which did not vitiate the result, but which accounts for the poor staining observed in some of the illustrations. Except in certain cases, all sections were stained with hæmatoxylin only. (See Fig. 471.)

Table II.—DETAILS OF 35 CONSECUTIVE EXPERIMENTS ON ANIMALS.

The animals used were cats, with the exception of No. 1 (guinea-pig), and Nos. 30–35 (frogs).

No.	DATE	OPERATION	RESULT
1	23.3.23	Carmine suspension injected into peritoneum	Killed 10.4.23. Sections of gut wall, mesenteric glands, great omentum, diaphragm and liver
2	25.4.23	Appendix ligatured and filled with carmine	Killed 4.5.23. Peritonitis. No sections taken
3	25.4.23	Carmine injected into spleen	Killed 7.6.23. Sections taken of spleen, mediastinal glands, pyloric glands, and liver. Smear taken of blood
4	5.5.23	Gall-bladder tied off and filled with carmine	Killed 17.5.23. Carmine had escaped into peritoneal cavity
5	14.6.23	Gall-bladder filled with carmine	Killed 22.6.23. Leakage of bile. Peritonitis

Table IV.—DETAILS OF 35 CONSECUTIVE EXPERIMENTS ON ANIMALS—*contd.*

NO.	DATE	OPERATION	RESULT
6	21.6.23	Appendix tied off and filled with carmine	Killed 26.7.23. Sections taken of appendix and gland, ileocaecal gland, pancreatic gland, spleen and liver
7	28.6.23	Loop of jejunum isolated and filled with carmine	Killed 1.7.23. Leakage of contents of loop
8	27.7.23	Loop of large intestine isolated and filled with carmine	Killed 1.8.23. Section taken of occluded gut, colonic gland, mesenteric gland, liver, and spleen. Smear of blood taken
9	27.7.23	Gall-bladder isolated and filled with carmine	Killed 1.8.23. Carmine had escaped into peritoneum. Smear of blood taken
10	30.7.23	Stomach isolated and filled with carmine	Killed 1.8.23. Sections taken of stomach, spleen, and liver
11	30.7.23	Loop of ileum isolated and filled with carmine	Killed 1.8.23. Section of occluded ileum, liver, spleen, ileal glands. Smear of blood taken
12	2.8.23	Carmine injected into lymphatic glands at base of mesentery, Indian ink into branch of portal vein	Killed 4.8.23. Section taken of liver, spleen, gall-bladder, stomach, kidney, spinal cord, knee-joint, bone-marrow, upper duodenum, lower duodenum and pancreas, ileum, appendix, colon
13	2.8.23	Gall-bladder isolated and filled with carmine	Killed 3.8.23. Section taken of gall-bladder, liver, spleen, pyloric gland, head of pancreas
14	26.11.23	0.5 grm. carmine into peritoneum	Killed 17.12.23. Sections taken of omentum, stomach, upper duodenum, lower duodenum, pancreas, upper ileum, lower ileum, large intestine, liver, gall-bladder, spleen, mesenteric gland, and mediastinal gland
15	29.11.23	0.5 grm. carmine into jugular vein	Died under anæsthetic. Duodenal cultures taken. Section of stomach, small intestine, appendix, large intestine, liver, spleen, kidney, lung, mesenteric glands, and gall-bladder
16	29.11.23	0.5 grm. carmine into branch of portal vein. Culture from duodenum	Killed 1.12.23. Sections taken of stomach, small intestine, large intestine, appendix, liver, spleen, kidney, and gall-bladder
17	10.12.23	$\frac{1}{2}$ c.c. carmine suspension into jugular vein	Killed 20.12.23. Sections taken of lung, liver, spleen, gall-bladder, stomach, duodenum and pancreas, small intestine, appendix, large intestine, mesenteric lymph glands, and bone marrow
18	10.12.23	Ileocaecal region tied off, and filled with emulsion of killed tubercle bacilli	Killed after 5½ hours. Sections taken of ileum, appendix, caecum, and ileocaecal gland
19	10.12.23	Carmine injected into lacteals of ileum, and glands at root of mesentery	Killed 20.12.23. Sections taken of stomach, duodenum and pancreas, small intestine, appendix and gland, large intestine, gland from lesser omentum, liver, spleen, gall-bladder
20	13.12.23	1 c.c. carmine suspension into branch of portal vein	Killed 22.12.23. Sections taken of stomach, duodenum and pancreas, small intestine, appendix and gland, large intestine, mesenteric gland, mediastinal gland, colonic gland, liver, spleen, gall-bladder, lung, and bone-marrow
21	13.12.23	Ileocaecal junction excluded, and filled carmine	Killed 14.12.23. Sections taken of appendix, large intestine, ileocaecal gland, liver, and spleen
22	17.12.23	Appendix tied off and filled carmine	Killed 21.12.23. Sections taken of appendix, stomach, liver, gall-bladder, pyloric gland, main mesenteric gland, ileocaecal gland, colonic gland, pancreatic gland, and spleen

INFECTIONS OF THE ALIMENTARY TRACT 781

Table IV.—DETAILS OF 35 CONSECUTIVE EXPERIMENTS ON ANIMALS—*contd.*

NO.	DATE	OPERATION	RESULT
23	19.12.23	Thoracic duct tied in neck, culture taken of contents. Carmine injected into mesenteric glands	Killed 31.12.23. Leakage of carmine from glands into peritoneal cavity. Sections taken of stomach, upper duodenum and pancreas, lower duodenum and pancreas, small intestine, appendix and gland, large intestine, liver, gall-bladder, spleen, lung, bone-marrow, glands from lesser omentum, mediastinum, head of pancreas, and inguinal region
24	19.12.23	Failure to find thoracic duct in neck	Cat killed on table
25	4.1.24	Ileocecal region tied off, and injected with suspension of hæmolytic streptococcus	Killed after 5 hours. Culture of pericardial fluid, heart blood, portal vein, thoracic duct, collecting lymphatics, and main mesenteric glands
26	5.1.24	Ileocecal region excluded, and 25 min. of 3 per cent protargol in saline injected	Killed 7.1.24. Sections of appendix and gland examined
27	10.1.24	2 c.c. of emulsion of streptococcus injected into ileum, without exclusion	Killed after 5½ hours. Cultures from heart (2), thoracic duct (2), collecting lymphatics (2), ileal gland, cæcal gland. Section of appendix and ileocecal gland examined
28	10.1.24	Ileocecal region tied off, and 1 c.c. streptococcal emulsion injected	Killed after 5½ hours. Culture from heart, thoracic duct, collecting ducts, ileocecal gland
29	31.1.24	Suspension of streptococci injected into duodenum	Cultures for heart blood, thoracic duct, collecting ducts, ileocecal glands, colonic glands, ileal glands
30-35	12.1.24	Greater part of small intestine tied off, and filled carmine	5 killed after 24 hours, 1 after 48 hours. Sections examined of gut wall, liver, spleen, kidney, and film of blood

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VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.

THE CLINIC OF PROFESSOR DE QUERVAIN AT BERNE.

IN visiting the Clinic of Professor de Quervain, one expects to see and hear a good deal about the technique and problems of the surgery of the thyroid gland. Five of such operations were witnessed. A visit was also made under the guidance of Professor de Quervain to an Institute in the neighbourhood which contained one hundred cretins. The number of cretins which must be kept in Institutions is at least 0·1 per cent. and probably nearer 0·3 per cent. of the total population: for example, in the canton of Berne, which contains 70,000 inhabitants there are at least 700 cretins who are so defective in intellect that they have to be kept at the public expense.

The operative technique seen in the thyroid operations was the same as that described in Professor de Quervain's book on goitre.

Local anaesthesia was used in all the cases. Novocain 0·5 per cent is the drug employed, to each 100 c.c. of which 4 minims of 1-1000 adrenalin has been added; 100 c.c. of this solution should be sufficient to produce adequate anaesthesia, and 200 c.c. is the maximum dose which should be employed. The great advantage of local anaesthesia is that the function of the recurrent laryngeal nerve is under control during the whole operation. It does away almost entirely with vomiting, and in the opinion of Professor de Quervain diminishes the risk of post-operative bronchitis and pneumonia.

Though the Professor is convinced of the advantage of local anaesthesia in operations on cases of exophthalmic goitre, yet a few drops of chloroform or ether are given during the short time that traction is distressing. In operating upon children a general anaesthetic is employed—usually a mixture of chloroform and ether. An injection of morphia, or morphia and scopolamine, is given before operation in every case.

The method which was shown us of producing local anaesthesia for thyroid operations was a combination of a paravertebral injection of the side chiefly affected, with a perithyroid injection into the opposite side; also subcutaneous and subfascial injection in the area of the skin incision. Any one of these methods alone is not sufficient to produce an adequate anaesthesia. The method has occasionally to be altered to suit special cases. About fifteen minutes are allowed to elapse between the injection and the operation.

Two assistants helped at the operations, in addition to the instrument sister. As there is no anaesthetist, one assistant can stand at the head of the patient and retract the skin and subcutaneous tissues without being in the way of the operator and the other assistant.

Professor de Quervain employs the few special instruments described in his book, the 'forceps à godet' being specially useful. It was agreed that though "not absolutely indispensable they are a very serviceable addition to the ordinary instruments". The suture material used is fine catgut, except for ligatures on the big vessels, in which thread is the material employed. The wound is usually drained with a glass drainage tube (Kocher's pattern) for from twelve to twenty-four hours. The skin is brought together by Michel clips, which are removed in forty-eight hours. In addition, two silkworm-gut

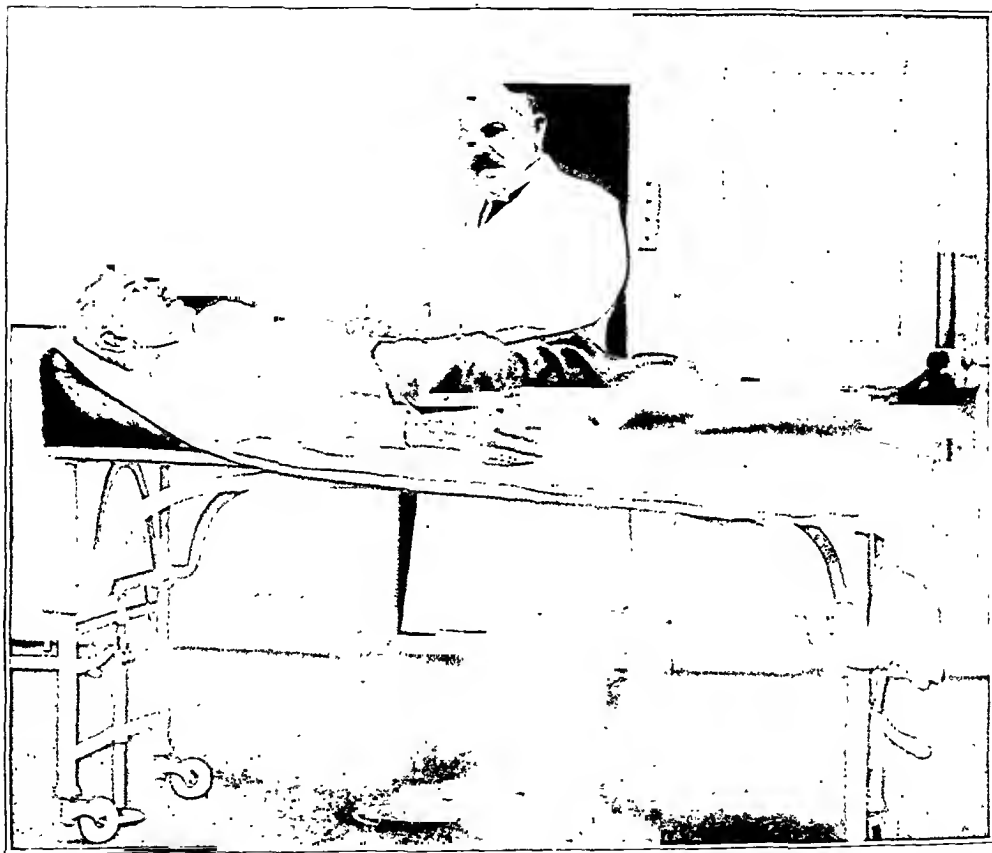


FIG. 472.—Professor de Quervain in his Clinic.

sutures are used to unite the skin, one on each side of the drainage tube. The operation table used is Professor de Quervain's own model. The patient can be placed in a semi-recumbent position with the head on a special rest so that the lower part of the neck is extended. One arm is fixed to the side of the table, the other is free so that the pulse can be observed during the operation.

The procedure usually practised in the Clinic is resection or enucleation, or a combined operation. Hemithyroidectomy is done only in very special

cases when the goitre is definitely unilateral: even then the upper pole and posterior portion are preserved in order to save the parathyroids and prevent injury to the recurrent laryngeal nerve.

All the operations witnessed were done on the following lines:—

The incision in all the cases was the 'incision en cravate' of Kocher. This is the usual one employed in the Clinic, and its level varies with the position of the goitre. The skin, superficial fascia, and platysma are divided, and the divided ends of the anterior jugular veins ligatured. A special feature of the operations witnessed was that all the vessels were ligatured as soon as possible, so that the usual crowd of pressure forceps seen in such operations was absent, with consequent diminution in the discomfort of the patient. In four of the five operations witnessed the inferior thyroid was tied next, either on one or both sides. The mode of procedure adopted in tying the inferior thyroid artery is fully explained in Professor de Quervain's book on goitre. Briefly the method is as follows:—

After the anterior jugular veins and any other vessel have been ligatured, the anterior edge of the sternomastoid is defined. The aponeurotic sheath of the small muscles is then incised for about one inch, in a direction parallel with the anterior edge of the sternomastoid; the middle of the incision being on the level of Chassaignac's tubercle, which corresponds usually with the level of the inferior thyroid artery. The finger is then passed between this aponeurotic layer and the small muscles, and the inner aspect of the carotid is felt. The finger then passes between the posterior lobe of the thyroid and the vertebral column. The inferior thyroid artery can be felt crossing the neck transversely in the space between the carotid and posterior aspect of the thyroid. It is freed by blunt dissection and tied in continuity. The recurrent laryngeal nerve and the parathyroids are separated from the operator by the thyroid fascia.

The only cases in which this part of the operation is impossible are those in which there is a large lateral goitre. In 2 to 3 per cent of cases the artery is absent. In one of the operations witnessed it was absent on the left side. It is claimed by Professor de Quervain and his colleagues that preliminary ligature of the inferior thyroid artery gives an easier operation than if immediate dislocation of the gland is practised. It also gives secure protection to the recurrent laryngeal nerve and the parathyroids.

The next step of the operation consists in incising the external capsule and entering the 'thyroid space'. The antero-external branch of the superior thyroid artery is tied, or even the whole of the upper pole of the gland. The lobe is then separated from the external capsule except at the posterior surface, so as to protect the recurrent nerve and the parathyroids. The lobe is then dislocated forwards. If there is any difficulty in effecting the dislocation, a loop of stout thread is passed several times through the substance of the lobe, and the two ends are tied and used as a tractor. This was done in two of the operations witnessed. Very little attention is paid to the venous hemorrhage at this stage, as the main arteries have been tied. It may be necessary at this point to cut the small muscles transversely, or, in the case of an intra-thoracic goitre, even the sternomastoid must be partially cut; but these muscles are preserved if possible. The lobe being dislocated, the amount

which is to be resected is determined. The resection is by a wedge-shaped or 'melon-slice' method. Hæmorrhage is stopped, and the raw surface of the thyroid tissue is then united with catgut. The same procedure can then be continued with the other lobe.

The operations witnessed were :—

1. RESECTION OF THE LEFT LOBE AND ENUCLEATION OF ADENOMA FROM THE RIGHT LOBE (*Operation, 8.35 to 8.52 a.m.*).—The patient was a woman, age 30, with colloid goitre in the left lobe and an adenoma in the right. There were slight cretinism and compression symptoms.

2. RESECTION OF EACH LOBE FOR COLLOID GOITRE (*Operation, 9.10 to 9.35 a.m.*).—The patient was a man, age 27, with a colloid goitre and compression of the trachea.



FIG 473.—Group of male cretins with and without goitre.

3. RESECTION OF RIGHT LOBE (*Operation, 10.0 to 10.30 a.m.*).—The patient was a woman, age 55. The left side had been operated upon some months previously, and at that time there was no evidence of goitre on the right side. "She is now complaining again of compression symptoms". Professor de Quervain remarked that it was often impossible to say how much the symptoms were due to the thyroid and how much due to a cardiac condition. The condition found on the right side did not seem to account for the symptoms.

4. RESECTION OF BOTH LOBES (*Operation, 10.35 to 11.15 a.m.*).—The patient was a woman, age 35, with a very large colloid goitre. The left lobe was resected first. The inferior thyroid artery on the right side could not be found. The major portion of the gland and isthmus was resected.

5. EXCISION OF A THYROID SINUS (*Operation, 11.30 to 12 noon*).—The patient was a woman, age 45, who had a goitre and also a sinus for eight years

following operation for a thyroid cyst. The sinus track was dissected out and found to originate in a cyst with calcified walls. No attempt was made to deal with the goitre, as the local condition was too septic.

All the operations were done with a rapidity, thoroughness, and decisiveness only gained by long experience and team work. Skiagrams of all the cases were shown and the salient points demonstrated.

The next day two operations were witnessed, one for the removal of an internal semilunar cartilage under a perfectly satisfactory local anaesthesia. The second was a case of gall-stones impacted in the common duct. The patient, a woman, age 70, gave a history of attacks of cholecystitis over twelve years. She had jaundice with the first attack, but not again until the present one. The operation was very difficult: two stones were



FIG. 471.—Group of female cretins with and without goitre.

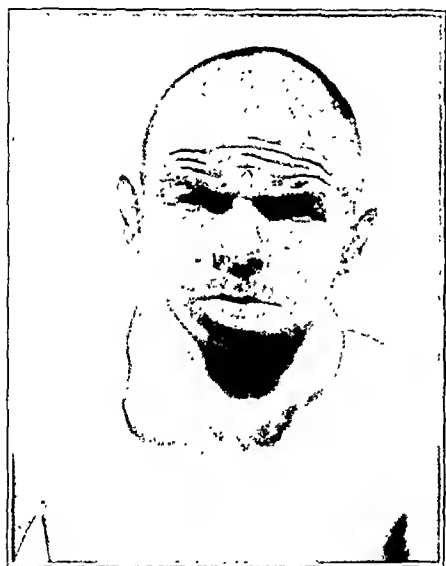
removed from the common duct, and one from a small shrunken gall-bladder very little larger than the stone and embedded deeply in the liver substance. General anaesthesia was employed.

The anaesthetic used was acetylene and oxygen after the method described by Dr. C. J. Gauss and Professor Hermann Wieland. The acetylene is pure, having been freed from the poisonous phosphoretted hydrogen, which also gives it the penetrating smell that is so characteristic of the acetylene used for lighting purposes. The pure acetylene has, however, a distinctive but not unpleasant odour, which can easily be disguised by scents. There is, moreover, a bitter taste; consequently the patient is instructed to breathe it with the mouth closed. It is administered mixed with oxygen by a Drager apparatus. The advantages claimed for the anaesthesia are that the patient is anaesthetized with a few breaths. Relaxation of the muscles is obtained to an extent which, if reached under nitrous oxide, would be a real danger.

The patient comes out of the anæsthesia in about a minute after the administration stops. There is one attack of vomiting immediately, and no later nausea or vomiting. The patient whom we saw anæsthetized by a nursing sister by this method did recover consciousness in about one minute, and vomited only once. Spoken to about an hour later she said she was very comfortable, and had no headache or nausea. The nursing staff were most enthusiastic about the advantages of acetylene anæsthesia.

The visit paid to the Cretin Institute at Reggisberg and the remarks made by the Professor on the thyroid problem of Switzerland were most interesting. His views are given in detail in his book on goitre.

As a general rule the cretin who is dwarfed and has an infantile genital development has an atrophied thyroid. On the other hand, those with a



FIGS. 475, 476.—Male and female cretins with goitre.

normal skeleton and genital glands usually have a goitre. The intellectual defect and deaf-mutism does not appear to be affected by the size of the thyroid. The thyroid factor, though important, is not the only one in the production of this malady.

The whole question of cretinism is one which has given the authorities much concern, as, in spite of all that has been done up to the present, the condition shows no signs of becoming more rare. It is too early yet to judge of the effect of giving 'iodized salt' as an article of diet to the whole population, which is at present being done. All the cretins in the Institute are employed to the utmost of their capacity. They are apparently a happy people who give very little trouble and enjoy their work on the farm or in the sewing room. They have to be seen, however, in order that the magnitude of the problem may be appreciated. (*Figs. 473-476.*)

SHORT NOTES OF RARE OR OBSCURE CASES

RETROPERITONEAL CYSTS.*

By R. ATKINSON STONEY, DUBLIN.

THE following case of retroperitoneal cyst is, I think, of sufficient interest to warrant its report.

A boy, age 12, was admitted to the Royal City of Dublin Hospital on Saturday evening, June 2, 1923, with symptoms of acute abdominal affection. He stated that on the previous Thursday he felt a stinging pain radiating from the left side of the abdomen; he took little notice of this, and went out, but when he got back he was so bad that he had to go to bed. He vomited once only. He got gradually worse, and on Saturday he was seen by a doctor, who sent him into hospital. On admission he was flushed, with furred tongue, pulse 100, temperature 99.8° , and respirations 28. The patient was doubled up with pain, his respirations were shallow, and there was rigidity over the right side of the abdomen, and tenderness in the right iliac fossa and towards the umbilicus.

The abdomen was opened through the outer border of the right rectus. There was a small amount of clear fluid in the right iliac fossa, and a small oval swelling was seen outside the junction of the cæcum and the ascending colon, with a patch of lymph on its summit. The appendix was normal. The swelling, which evidently contained fluid, was seen to spread towards the middle line behind the ascending colon, which was more or less flattened. After the general peritoneal cavity had been packed off, the swelling was opened outside the ascending colon, when several ounces of fluid escaped, at first purulent, then serous, with masses of fibrinous exudation. On exploring the interior of the cavity it was found to stretch as far as the middle line, downwards to the ileocecal angle, and upwards to the region of the duodenum. Some B.I.P.P. was put into the cyst cavity, and a split rubber tube with a B.I.P.P. gauze wick. The opening in the cyst was closed with a purse-string suture around the tube, and fixed to the anterior parietal peritoneum. The edges of the wound were then closed tightly around the tube. The discharge, which at first was considerable and purulent, soon diminished and became serous; in three weeks it had ceased and the wound closed, the patient leaving hospital on the twenty-fifth day after operation. Some of the exudate

* Paper read before the Surgical Section of the Royal Academy of Medicine in Ireland, Dec. 7, 1923.

from the interior of the cyst was sent to Trinity College for examination, and was reported to be fibropurulent exudate with numerous organisms.

The origin of retroperitoneal cysts appears to present difficulties and uncertainty. The usual classification is into five groups:—

1. *Serous Cysts*.—These are usually regarded as embryonic in origin, owing to their proximity to the kidney and the possibility of their development from the remnants of the Wolffian body and duct of Müller.

2. *Blood Cysts*.—These may be due to hæmorrhage into the retroperitoneal tissues from trauma, or may arise from hæmorrhage into a preformed cyst.

3. *Chylous Cysts*.—These may arise in connection with the thoracic duct, the receptaculum chyli, lacuna mesenterica, a degenerated mesenteric gland, or rupture of a chyle duct between folds of peritoneum.

4. *Dermoid Cysts*.—These may arise from foetal inclusions and remains of the development of the genito-urinary apparatus; they may attain a very large size, and may be partly solid and partly cystic or multilocular.

5. *Hydatid Cysts* need no explanation, and are rarely seen in this country.

The knowledge obtained from the histological examination of the structure of the cyst wall is not yet sufficient to warrant an attempt at a genetic classification. In this case it was not possible to obtain a piece of the wall for examination. This case plainly belongs to the class of serous cysts in which inflammation had occurred. The most probable source of the infection was from the bowel, though what originated the migration of organisms through the wall of the intestine is not evident.

Admitting the embryonic origin of this cyst, I would like to suggest another source rather than the Wolffian body or the duct of Müller, namely, the space between the peritoneum covering the posterior wall of the abdomen on the right side and the primitive mesentery of the large intestine. In early foetal life the abdominal cavity is completely lined by peritoneum, and the gut is in the form of a straight tube, slung medially to the posterior wall by a mesentery. During the course of development the alimentary canal greatly elongates and is thrown into folds; the mesentery proper of the adult, however, is the representative of the original mesentery. In addition to this elongation of the gut there is also a rotation round the vertical axis of the abdomen, contra-clockwise, whereby the cæcum comes to lie in the right iliac fossa and the transverse colon crosses the duodenum. During this process the peritoneum of the mesentery of the cæcum and the ascending colon blends with the peritoneum covering the posterior abdominal wall to the right of the primitive mesentery. When this fusion is imperfect, we find the cæcum and ascending colon provided in varying degrees with a mesentery; and when fusion occurs at the periphery but not throughout the whole area, fluid might accumulate and a cyst might form as in this case. The boundaries of the space over which this fusion occurs normally are the root of the mesentery proper towards the middle line, the attachment of the transverse mesocolon above, and the cæcum and the ascending colon on the outside. These were exactly the outlines that were found to define this swelling. A cyst forming between the layers of the mesentery of the cæcum and the ascending colon would have the same limits; but it would probably develop anterior to the vessels supplying the intestine, or if it was an extravasation cyst it would

probably have these vessels traversing its cavity. The cyst might also tend to spread between the layers of the transverse mesocolon. In this case, however, the right colic artery was in the thick anterior wall of the cyst. If the cyst formed in the manner suggested, the anterior wall would be formed by two layers of peritoneum with the intervening tissues, and would be less liable to give way than the line of blending of the mesenteric and parietal peritoneum, outside and behind the ascending colon, where, as a matter of fact, the wall of this cyst was thinnest and on the point of bursting.

If the cyst was formed from the Wolffian body or the duct of Müller, it is hard to see how infection could have occurred, for it would have been separated from the intestine by the parietal peritoneum, as these structures lie behind it, and experience proves that the parietal peritoneum forms a strong barrier to the spread of infection. If the origin suggested above is accepted, infection from the intestine is more easily explained, as it would only have to traverse the layer of peritoneum covering the ascending colon, and this part of the intestine was already interfered with by the pressure of the large cyst developing behind it.

It has been suggested that some of these cysts are formed by the collection of fluid in the retroperitoneal fossæ, which have become closed by inflammatory adhesions, such as the subcecal, duodenojejunal, and intersigmoid. This origin, however, would not explain the size and ramifications of this cyst.

The diagnosis of these cysts is usually difficult, and in this case was further masked by the superimposed symptoms of inflammation which made it appear like a typical case of appendicitis. The treatment is drainage or complete extirpation. In this case extirpation was contra-indicated, not only by the size of the cyst but also by the complicating inflammation.

A CASE OF ACUTE OBSTRUCTION AT THE SITE OF A GASTROJEJUNOSTOMY.

By REGINALD KEENE, OULTON BROAD, SUFFOLK.

THE following case is, I think, sufficiently rare to be of interest. The patient, a man, age 49, was admitted to the Norfolk and Norwich Hospital on June 26, 1924, in such a collapsed condition that it was thought improbable he would survive surgical intervention. Almost exactly three years previously he had been admitted to this hospital with a duodenal ulcer which had perforated seven and a half hours previously; he gave a history of only three weeks' 'indigestion' preceding this. On that occasion a perforation was found in the anterior duodenal wall—about a quarter of an inch in diameter and near the pylorus. The ulcer was closed and invaginated and a posterior gastro-enterostomy performed through an opening in the transverse mesocolon. The abdomen was closed without drainage. He was discharged three weeks later soundly healed after an uninterrupted convalescence. He remained well except for some constipation and occasional slight epigastric pain until

four days prior to his re-admission. He was then seized with violent epigastric pain, which was followed by persistent projectile vomiting. Both pain and vomiting continued until admission. His bowels were opened naturally on the day he entered hospital, nothing abnormal being noticed by him in the stool.

ON ADMISSION.—The patient looked desperately ill; he was emaciated, ashen-grey, with bright eyes, and an anxious expression. Temperature 99.6° ; respirations 26; pulse very feeble and rapid, about 160. Marked tetany was present with typical contractures in both hands. The tongue was dry and heavily furred. In the heart and lungs there was nothing abnormal. The abdomen was markedly retracted, but was soft except for comparative rigidity of the upper recti. There was some tenderness above and to the right of the umbilicus. No tumour was palpable. 'Splashing' was detected in the stomach area, and dullness in either flank. A provisional diagnosis was made of perforated anastomotic ulcer, and laparotomy was performed under general anæsthesia, through a central suprapubic incision.

CONDITION AT OPERATION.—Omentum presented, beneath which lay coils of collapsed small intestine and colon, presenting a normal appearance. There was no excess of peritoneal fluid. The stomach reached below the level of the umbilicus. The incision was enlarged upwards, and on turning the stomach upwards a distended loop of small intestine was seen running vertically to be attached to the posterior wall of the stomach. To the right of this was the terminal portion of the ileum which could be traced from the ileocæcal junction upwards and to the left until it disappeared behind the distended loop. To the left lay the rest of the small intestine with its mesentery—collapsed and normal in appearance.

It was decided that the distended intestine must be part of the proximal

loop of the gastro-enterostomy, and as during manipulation a tear appeared at the point of juncture, the anastomosis was cut through along the old suture lines, and the two openings were clamped. It then became obvious that the whole of the small intestine had migrated from right to left between the stomach and proximal loop of the anastomosis so as to lie in the left flank, and that the drag of the mesentery on the proximal loop, with the bulk of the intestines rotating the anastomosis to the right through 90° and at the same time pulling the distal loop to the left, had so contorted the actual stoma as to produce complete obstruction at that point, with acute dilatation of the stomach and duodenum. The herniated intestine could now readily be returned to its

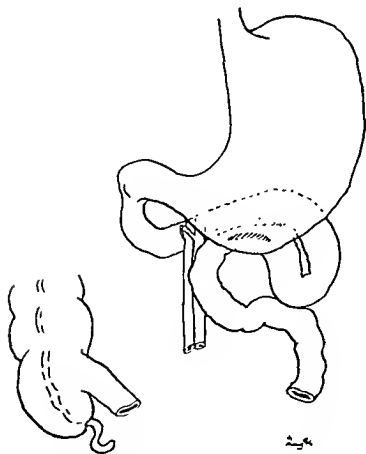


FIG. 477.—Normal gastrojejunostomy.

normal situation. A tube was passed into the stomach through the old stoma and several pints of thin offensive fluid were evacuated; the anæsthetist almost immediately reported a marked improvement in the patient's condition. Through the old stoma in the jejunum a pint of peptonized milk

was introduced containing half an ounce of brandy and four drachms of sugar. The anastomosis was reconstructed, using catgut throughout, and while the abdominal wall was being closed a pint and a half of gum-saline with 6 per cent glucose was given intravenously. The patient's condition had now greatly improved, and by the next morning he had a bounding pulse-rate of 72. From then onwards he made a straightforward recovery, and was discharged, twenty days after admission, to our convalescent home. Seen fourteen days later, he looked, and said he felt, remarkably well, and had put on 7 lb. in weight. He had had no dyspeptic symptoms.

The interesting points of the case are:—

1. The clinical picture presented by the patient on admission: there were some signs suggesting a perforated viscus, but the tetany should have suggested gastric dilatation; the tetany, which was very marked, disappeared with deep anaesthesia and was not subsequently observed.

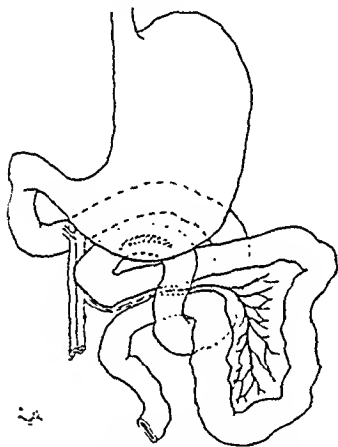


FIG. 478.—Upper coils of jejunum beginning to migrate.

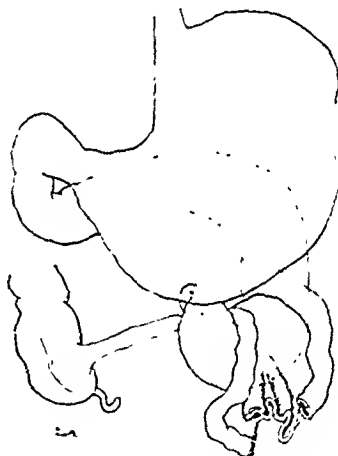


FIG. 479.—All except terminal ileum has migrated through opening, and obstruction has occurred at anastomosis.

2. The findings at operation. The mechanism is, I think, explained by the diagrams (Figs. 477, 478, 479); presumably the migration was only completed suddenly, and, just as a hernia becomes strangulated by the sudden arrival of additional coils, so the advent of the remaining intestine was sufficient to kink the anastomosis suddenly and give rise to the acute symptoms. Why the migration should have commenced in the first place is at present inexplicable.

3. The marked improvement in the patient's condition after evacuating his stomach, and the good effect of the administration of peptonized milk along with brandy and glucose by the small intestine, as well as saline intravenously.

From a condition in which operation seemed almost certain to prove fatal, the patient passed into a far less grave state during the operation itself, and within twelve hours after gave no cause for anxiety at all.

I am indebted to Mr. Blaxland, who performed both operations, for permission to publish these notes.

A CASE OF FRONTAL ENDOTHELIOMA WITH HYPEROSTOSIS CRANII.

(*Pacchionian Tumour?*)

By ZACHARY COPE, London.

THE following case is of interest in that it fits in with the accounts of those rather rare tumours of the skull which are now regarded as Pacchionian in origin.

Albert N., age 52, was admitted to St. James's Hospital on Feb. 18, 1923, for an injury to the leg. The injury had been caused by a fall due to a fit. Examination showed that he had



FIG. 480.—The patient before operation.

a fractured fibula. He also presented a deformity of the head, for which I was asked to see him on Feb. 26. When first I saw him there was great asymmetry of the skull (*Fig. 480*) due to a large swelling in the frontal region. The swelling covered the posterior part of the left frontal bone, but extended beyond the middle line for an inch or so. It was hard, painless, fixed to the bone, and itself appeared of bony consistency. The patient asserted that he had noticed a swelling there for between ten and twenty years. He had begun to suffer from epileptic fits ten years ago, and these had become more frequent of late; one now occurred every ten or fourteen days. The Wassermann reaction was negative and there was found no focus of primary cancer which might have led to a secondary growth in the skull. I ventured a tentative diagnosis of primary endothelioma. Apart from the fits there were no signs of increased intracranial pressure.

With a view to relieving the fits, on April 16 I turned back a flap of scalp and exposed the tumour. It was found to be composed of rather soft porous bone. Although I trephined to a depth of about two inches the dura was not reached, and since the patient was none too well I did no more than remove some of the bone. The pathological report said the sections showed a spindle-celled sarcoma.

After this operation the swelling grew quickly and I contemplated further operative measures. At this time I saw a reference to Penfield's work in an article by Sir John Bland-Sutton.¹ Penfield² in 1923 described certain



FIG. 481.—Section showing the cellular structure of the growth. ($\times 225$.)



FIG. 482.—Section showing relations of bone and masses of growth. ($\times 56$.)

tumours which caused great enlargement of the skull and were probably derived from the Pacchionian bodies. It occurred to me that the case under observation corresponded with his account. Sir John kindly saw the case with me and agreed with my surmise, and advised further operative treatment.

On Nov. 26, 1923, I therefore exposed the mass again by reflecting the scalp. The bony tumour was now covered by a thick layer of white gelatinous tissue. I removed this together with a large portion of the projecting bony mass. The dura mater was exposed over the superior longitudinal sinus. The parts removed were forwarded to Sir John, who had sections cut (*Figs. 481, 482*), which bore out his opinion that the tumour was one of those to which the term Pacchionian might be applied. After the operation the patient did not have a fit for a long time, but he still has an occasional one.

By naked-eye examination of the bone removed the soft channels of growth could be seen in the midst of the harder tissue, and it was evident that the growth itself must have formed new bone.

The remarkable features of the tumour are its very slow growth, the absence of symptoms for years after its commencement, and the lack of localized cranial symptoms owing to the growth enlarging only outwards. Epileptic fits were the only cerebral symptoms.

COMMENTS ON THE CASE.

From the above account and from the study of the accompanying sections it is clear that we are concerned with an endothelioma which had its origin within the skull and which invaded the bone, whilst at the same time causing the deposit of much new bone.

The following questions present themselves: (1) *From what tissue do these tumours arise?* (2) *What is the best name to apply to them?* (3) *How frequently do they lead to perceptible bosses on the exterior of the cranium?* (4) *What is the best treatment?*

1. Though originally thought to arise from the inner layer of the dura mater, there now appears to be a consensus of opinion among those who have studied these tumours specially that they spring from the arachnoid membrane. Penfield quotes Schmidt in support of this view. Schmidt put forward his opinion in 1903. Mallory in 1920 came to a similar conclusion and suggested the name *arachnoid fibroblastoma*. In 1922 Cushing,³ speaking of his researches on these tumours (carried out with Weed), said, "It is our belief that they arise from the cell-clusters of the arachnoid villi projecting into the dura". Cushing suggested the names *meningioma* or *meningothelioma*. Since a good proportion of these tumours grow from the frontal region near the mid-line, it is quite likely that many take origin from a Pacchionian body.

2. If it be agreed that the arachnoid membrane is the site of origin of these endotheliomata, it would be wise to adopt a name which would indicate that origin. The names suggested by Mallory and Cushing do not seem altogether suitable. Nor is it wise to apply the term Pacchionian as a general descriptive epithet for all these tumours, for, whilst applicable to those arising in the frontal region, it would not serve for temporal endotheliomata. I venture to suggest that the name which would be most generally applicable and sufficiently descriptive is *arachnoma*.

3. In a series of over 400 intracranial tumours which were studied by Penfield there were 10 cases of a similar nature to the one described above, whilst in the 80 cases of endotheliomata included in the 748 verified intra-cranial tumours under Cushing's care only 20 caused recognizable thickening of the overlying bone. Many of the cases in these series caused only small bosses on the overlying skull, so we may conclude that it is quite rare for such a large boss to be developed as in the case related.

As to which of the endotheliomata cause the bony changes, we may with advantage quote Cushing, who says: "Tumours which are parasagittal in origin and those which arise from the temporo-frontal meninges adjacent to the Sylvian cleft seem to be accompanied by a hyperostosis cranii more often than those in other situations".

4. These tumours are very benign, grow very slowly, cause few symptoms—and those rather late—but progress steadily until after some years an unsightly deformity of the head is produced. When they have attained a great size there is considerable danger that an attempt to remove them may cause the patient's death from hæmorrhage or from shock. When they are small it is not so difficult to cut through the healthy bone all round the boss and so remove the affected part.

In operating on the large tumours the operation should be done in at least two stages, or only a partial operation attempted. In the case of my own patient I have relieved symptoms by removal of part of the bony mass: if further symptoms arise, I shall attempt a further removal. Several deaths have been recorded from operation on these large tumours.

I am indebted to Sir John Bland-Sutton for the sections from which the drawings were made, and for the loan of *Fig. 480*. The photograph of the patient was kindly taken by Dr. Pigott.

REFERENCES.

- ¹ BLAND-SUTTON, *Brit. Med. Jour.*, 1923, i.
- ² PENFIELD, W. G., *Surg. Gynecol. and Obst.*, 1923, xxxv, 657.
- ³ CUSHING, *Arch. of Neurol. and Psychiat.*, 1922, viii, 139.

RENAL CALCULUS AND HYPERNEPHROMA.

By H. P. WINSBURY WHITE, LONDON.

THE specimen was obtained by operation from a man, age 31, who was sent to me suffering from a urethral fistula. His history was that two years previously he had a peri-urethral abscess, which was incised, and a urinary fistula resulted. The cause of the abscess was not clear from the patient's story. Gonorrhœal infection was denied. In the intervening period two operations had been performed on the fistula. At the second, suprapubic cystotomy was performed in addition to the perineal incision. Benefit was only temporary, as after each operation healing was incomplete and the fistula persisted.

On examining the patient when he first presented himself there was a

considerable amount of scar tissue and inflammation about the perineum surrounding the fistula, which was found to communicate with the bulbous urethra. It was expected that the passage of a sound would reveal a tight stricture. A 12/14 sound (English scale) was, however, readily admitted, and at the same time the presence of a stricture was detected. It was hoped that treatment of the stricture by intermittent dilatation would suffice to remedy the perineal condition. This line of treatment was therefore followed for six months, but the fistula failed to improve. Cystoscopy was then carried out, when turbid urine was seen coming from the left ureter, and clear urine from the right. A radiogram revealed a stone in the left kidney. I operated on

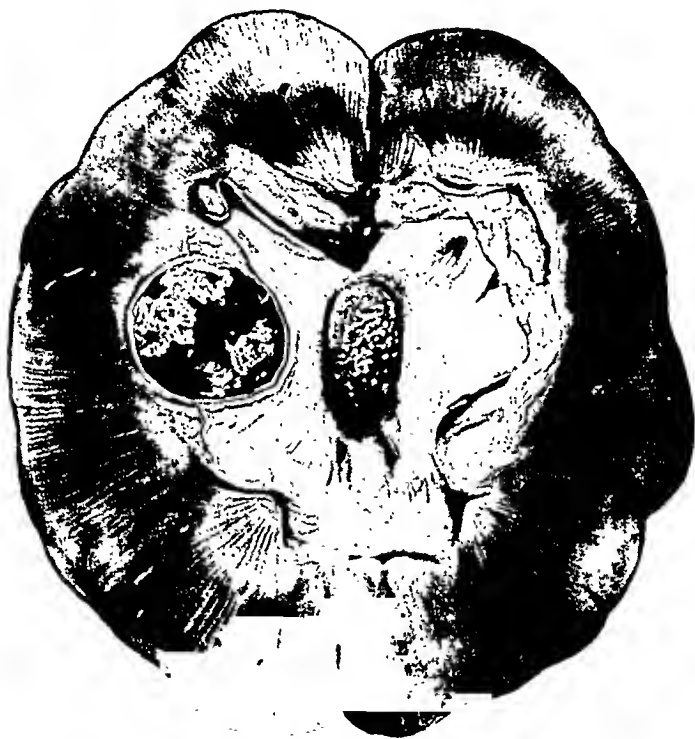


FIG. 483. —Kidney split, showing new growth and stone.

this kidney, and removed from the pelvis by pyelolithotomy an oxalate stone about the size of a filbert nut. A bluish bulging area having a diameter about equal to that of a shilling piece was then noticed on the outer aspect of the kidney about its middle. On palpation with the forefinger in the pelvis it was noted that this area was somewhat softer than the rest of the organ. As the opposite kidney was known to be functioning well, and the swelling under consideration suggested new growth, I removed the kidney.

On dividing the kidney afterwards an encapsuled growth with a diameter of about $\frac{3}{4}$ in. was revealed, as seen in Fig. 483, which also shows the stone in the position from which it had been removed.

There are several interesting features in the case. The tumour was exceptionally small, and was situated much nearer to the pelvis than such tumours generally are. It appeared to be completely encapsuled. Dr. Scott Williamson described the growth as a typical hypernephroma which had already infiltrated its capsule. It is interesting to note that the patient had never suffered from pain in the left loin, nor had there been any hæmaturia, apart from an odd drop of blood following the passage of a sound. The most striking clinical feature of the case, however, was the fact that the persistence of the fistula was due entirely to the infected urine arising from the presence of the renal stone. From the appearance of the kidney it could be seen that the infective changes were very slight and confined to the pelvis. Yet, a fortnight after nephrectomy was performed, the perineal fistula, which had resisted all forms of local treatment for two years, was completely healed.

TWO CASES OF ABNORMAL PATELLÆ.

By M. J. PETTY, BUENOS AIRES.

1. **Congenital Abnormal Bilateral Patellæ.**—In this case the patient said that since earliest childhood he had had two knee-caps on either side, and increased difficulty in walking. His parents stated that he had



FIG. 484.—Abnormal bilateral patella
(right side).



FIG. 485.—Abnormal bilateral patella
(left side).

never received any injury in the neighbourhood of the joint, and as ossification of the patellæ starts from the second to the sixth year, the condition

to be described might rightly be regarded as congenital, and as such seems to be a unique case. Other cases of double patellæ, hitherto described, have a longitudinal division, whereas here the division is horizontal, as seen in radiograms of the bone; and furthermore, in this case ossification must have originally started in two centres, one above the other.

The patient called for medical assistance as he had slipped into a hole in a field, causing sudden pain in his knee and considerable difficulty in walking. On examination, about three hours after the accident, there was apparently separation of the fragments but no effusion of blood into the tissues, and on examination of the left knee a similar condition was evident, but without so much separation of the fragments. Evidently on the right side the tendon of the quadriceps between the patellæ had been torn, giving rise to the appearance of a fracture of the patellæ without an effusion of blood. On inquiry, the above history was elicited, showing that we were dealing with a traumatism of a congenital abnormality.

X-ray appearances show a larger upper and a smaller lower patella. In both cases the upper fragment is somewhat dome-shaped, and its lower aspect is quite distinct from the appearance of that seen in a case of fracture. The lower fragment is more quadrangular, but has not the clean-cut appearance of a fracture. The separation on the right side is greater on account of the tear in the quadriceps tendon. (*Figs. 484, 485.*)

Under local anaesthesia, the opposing patellar surfaces were roughened, the bones wired, and the tendons sutured. Seen a year after, there was good bony union.

2. Osteoma of Right Patella in a Case of Congenital Dislocation of Patella.—This case is of interest in so far as it presents an apparent form of duplication of the patellæ, but this appearance is in reality due to an osteoma growing from the upper border of the right patella (*Fig. 486*). The patient, a labouring man, was able to get about satisfactorily.

FIG. 486.—Osteoma growing from upper border of dislocated patella.

A CASE OF RECURRENT ENTERIC INTUSSUSCEPTION IN A CHILD, DUE TO SIMPLE TUMOUR.

By L. E. BARRINGTON-WARD, LONDON.

For the earlier notes of this case I am indebted to Dr. David Russell, of the British Hospital, Lisbon. The case appears to be sufficiently rare to be worth recording.

R. B., a female, age 6, was suddenly seized with abdominal pain and vomiting on Oct. 18, 1923. For two years she had been in indifferent health, and had suffered from occasional attacks of abdominal pain and vomiting, which passed off. On this occasion the pain and vomiting were much more severe and showed no sign of abating. On palpation a sausage-shaped tumour was found running from above downwards, from left to right, from 2 in. above the umbilicus to a point some 2 in. below. With the onset of pain, the tumour was felt to harden. Operation was performed immediately by Dr. Russell, and a large intussusception of the small intestine was discovered. The bowel was engorged and purple, but by compression aided by gentle traction the invagination was reduced, some 12 in. of intestine being drawn out of the intussusciptions. As the condition of the child gave rise to some anxiety, the abdomen was closed as quickly as possible. After a few anxious days a good recovery was made.

Two weeks later, pain and vomiting began again, and the sausage-shaped swelling reappeared. Laparotomy was again performed, and an intussusception apparently identical with that of the first operation was found and reduced. Some large glands were noticed, and tubercles on the peritoneal surface of the intestine, and the intussusception was deemed to be due to irregular peristalsis caused by abdominal tuberculosis. From the second operation the child made a good recovery, and returned home on Nov. 26, 1923.

On March 18, 1924, Dr. Russell was called urgently to see the child, and found for the third time the unmistakable trio of pain, vomiting, and tumour. On this occasion, by manipulation through the abdominal wall, the tumour was reduced, and the abdominal wall became soft and flat, and the child felt well again. From this time onwards mild attacks of abdominal pain and vomiting occurred, but always passed off with the administration of an enema and the application of heat to the abdomen.

On Aug. 8, 1924 (the child in the meantime having been brought to England), another attack ensued, and Dr. J. Douglas Clarke was called in. He found all the clinical features of an acute obstruction, and a large tumour occupying the middle of the abdomen. I saw the child a few hours after the onset of the attack, and found her rather collapsed and vomiting frequently. Enemata had produced no result. There was a large tumour palpable, running from left to right and above downwards across the centre of the abdomen. It hardened and relaxed, and with the hardening pain occurred. Immediate operation was advised. Not unnaturally, in view of the previous history, the mother was anxious for minor measures to be tried first; but the serious and advanced state of the condition was explained, and consent obtained.

At operation an enteric intussusception was found. The ensheathing layer was distended to about the diameter of the adult cæcum. Reduction was accomplished with much difficulty. Pressure of the ensheathing layer merely caused the peritoneum to split, and it was only by traction on the entering tube that reduction was accomplished. The bowel was withdrawn in three distinct sections: resistance was felt three times, and on each occasion a gush of fluid occurred with the overcoming of the resistance. It appeared that the intestine had been involuted within itself three times. About 3 feet of jejunum was affected. The bowel was examined and some

patches of œdema were felt, but no definite tumour. The glands were slightly enlarged, but no tubercles were seen. The disparity of size between the more or less normal proximal bowel and the hugely distended distal part suggested that a recurrence of the intussusception in a short time was absolutely certain. Accordingly, the parents were advised that after recovery from this operation the affected part ought to be resected. No lesser palliative means, such as suture of the mesentery, appeared capable of preventing recurrence.

The child made a good recovery, but on one or two occasions Dr. Clarke had to reduce the intussusception in an early state of formation by manipulation through the abdominal wall.

On Sept. 17 I operated again, and found 6 in. of intestine intussuscepted, although there had been no immediately previous symptoms. It reduced easily. On careful examination it was now possible to feel distinctly two groups of tumours in the bowel, some 6 in. apart, and it was evident that these were the cause of the intussusception. The general engorgement and œdema at previous operations had prevented recognition. No other tumours could be felt, and except for the presence of a large round worm in the lower ileum the abdomen seemed normal. About 10 in. of intestine containing the tumours were resected (*Fig. 487*), and a side-to-side anastomosis was performed. The child made an uneventful recovery and improved rapidly in health, and now appears perfectly well.

Dr. Nabarro reported that the tumours were of the nature of an adeno-papilloma.

Benign tumours of the small intestine in children are uncommon. When I first saw the case I was not provided with Dr. Russell's excellent notes, and I rather discounted the diagnosis of recurrent enteric intussusception because of its rarity. It appeared to me more likely a case of partial volvulus of the small intestine.

I have not seen a case before in which it was possible to reduce an intussusception in its early stages by manipulation through the abdominal wall. This was done on at least three occasions by two different observers. The mother, who was a fully-trained nurse, and whose observations appeared reliable, was quite certain that she had cut short many attacks by administering an enema. It is conceivable that the enema initiated reverse peristalsis.

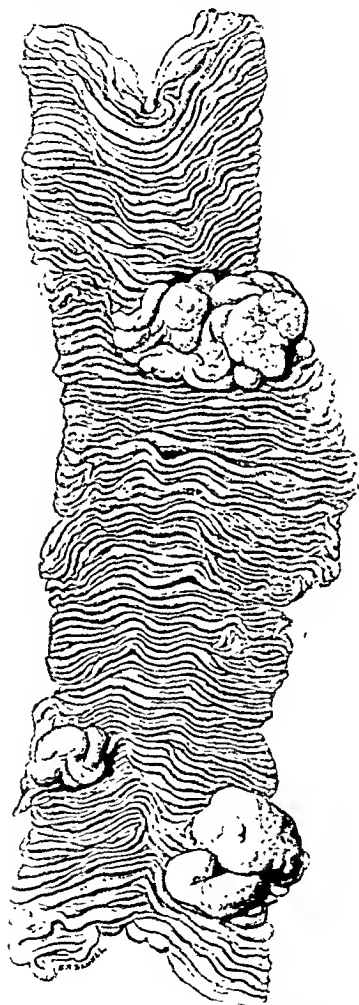


FIG. 487.—Section of ileum, showing tumours the cause of intussusception. ($\times \frac{1}{2}$.)

IMPACTION OF A GALL-STONE IN THE UPPER JEJUNUM: ACUTE OBSTRUCTION: CYSTIC PNEUMATOSIS OF THE JEJUNUM ABOVE THE OBSTRUCTION.

By DOUGLAS DREW, LONDON.

M., A MALE age 70, had suffered for years with indigestion and ill-defined symptoms suggestive of gall-stones or gastric trouble. More recently he had had attacks of vomiting, and a fortnight before the onset of obstruction, hæmatemesis and mælena occurred, associated with attacks of severe abdominal pain. There had been no trouble with the bowels until forty-eight hours before I saw the patient. He had a weak heart and albuminuria.

On Sept. 6, 1924, I was asked by Dr. Stokes to see him on account of the acute obstruction. The vomiting was insistent, at first of greenish colour, and later brown, with a stereoral odour. It was obvious that operation was urgently needed, but I was somewhat puzzled by the condition of the abdomen, which was not distended but flaccid; nothing could be felt, but there was tenderness on the left side.

On opening the abdomen to the left of the umbilicus, a distended and discoloured coil of small intestine presented, together with other coils which were pale, empty, and contracted. On tracing the distended coil upwards, the duodeno-jejunal flexure was at once reached, while on following it downwards for a short distance into the left flank, a large oval mass was found tightly impacted in the bowel at a distance of about eighteen inches from the flexure. Below this the bowel was about the normal size and slightly injected for about twelve inches, where a second stone of smaller size was found; below this the bowel was pale and contracted. As this smaller mass did not appear to be causing obstruction, an attempt was made to manipulate it upwards to remove it with the larger mass through the same incision, but this could not be done, so it was removed through a second incision. Just above the site of impaction of the larger stone there was some lymph on the wall of the bowel.

At irregular intervals along the distended bowel were situated a number of soft round projections from the intestine into the mesentery. I counted five; the largest was about three-quarters of an inch in diameter, and the smaller ones varied in size from that of a small marble to that of a pea; on manipulating them gently they collapsed and disappeared, distinct soft emphysematous crackling being felt, but they reappeared at once. Owing to the urgent nature of the case, a detailed examination could not be made, but no sacculation was present in the collapsed coils or in the transverse colon.

The two portions of the stone fitted together fairly well and suggested that it had fractured; it may, however, have been due to faceting. The measurements were: length, when fitted together, $2\frac{1}{4}$ in., breadth $1\frac{5}{16}$ in., circumference $4\frac{1}{4}$ in. It was greenish-black in colour, and rather friable.

Although the smaller mass had not caused obstruction, in that the bowel was not distended and discoloured as it was above the larger mass, yet it was obviously necessary to remove it, as it might have given trouble in the

narrower ileum, and it was most important not to have any possible cause of interference with the onward passage of the contents after the obstruction caused by the larger mass had been relieved. The absence of distention is explained by the high level of the obstruction.

The case appears to be worthy of record, as an impacted gall-stone is one of the rarer causes of obstruction, while it is still more unusual for the impaction to occur at so high a level.

The chief interest, however, lies in the condition of the bowel above the obstruction. I had recently read with much interest Mr. P. Sargent's exhaustive article on cystic pneumatosis, from which it appears that the gas may be in closed spaces or it may form a bleb on the wall of the bowel from which it may be displaced by gentle pressure, as in the case under notice.

Whatever the cause of its production, all the conditions mentioned by Mr. Sargent were present; it may have been caused by: (1) The mechanical pressure of the obstruction and the vomiting forcing gas into the tissues through abrasions in the mucous membrane produced by the gall-stone; (2) By bacterial infection of the wall of the damaged bowel; or (3) The lesion may have pre-dated the obstruction, as an ulcerative lesion—probably in the duodenum—must have been present in order to account for the passage of the gall-stone into the intestine.

I think the first is the most probable explanation, as if it had been caused by bacterial infection, there would probably have been signs of inflammation around the blebs. The chief point in which the case differs from the others is that the blebs were entirely along the mesenteric border.

The after-history is brief, as the patient died from sudden cardiac failure before he recovered from the anæsthetic.

REVIEWS AND NOTICES OF BOOKS.

Modern Operative Surgery. Edited by H. W. CANSON, F.R.C.S., Senior Surgeon, Prince of Wales Hospital, Tottenham, etc. In two volumes. Royal 8vo. Vol. I, pp. 784, with 365 illustrations; Vol. II, pp. 784, with 370 illustrations. 1924. London: Cassell & Co. Ltd. £3 3s. net.

THE editor of these volumes states in his preface that they are "an attempt to present the whole range of modern surgical operations . . . and to exclude those that have lost their usefulness and to include only those new operations which have proved their value". We think that the editor and his colleagues have carried this out in a most admirable manner.

This work is a very welcome change from the usual type of operative surgery text-book, in that not only is the technique of operations fully described, but the theoretical considerations of indications for operations, the rationale of the operation, and the prognosis are also fully dealt with. That the exclusion of old, classical operations not now used has not been carried to excess is witnessed by the inclusion of Syme's external urethrotomy; in the place of those that are really obsolete are a vast number of new surgical procedures now in general use, many of which appear for the first time collected in a text-book. This is where an entirely new work on operative surgery is so superior to revisions of old, many-editioned text-books.

Amongst special features is the inclusion of a chapter by Sir Henry Gauvain on the conservative treatment of surgical tuberculosis. Two chapters from the pen of Mr. Sampson Handley are deserving of particular notice. They deal with both the theoretical and the practical aspects of the operative treatment of malignant disease and of operations on the breast. The chapters on abdominal surgery are very complete, and give in a most practical way all the modern operative treatment of abdominal conditions. Mr. H. D. Gillies contributes a valuable chapter on plastic surgery. In addition to these and other chapters on special subjects such as operations on the ear, nose, and throat, and gynaecological operations, the whole of operative treatment is well covered.

The volumes are well printed on good paper, and are profusely illustrated, and there are many valuable references to original articles. They form most worthy companions to the already well-known three-volume *System of Surgery* produced by the same publishers. We must congratulate the editor and publishers on having produced a work which will be of great value to all those who practise surgery.

Goitre: A Contribution to the Study of the Pathology and Treatment of the Thyroid Gland. By F. DE QUERVAÏN, Professor of Clinical Surgery in the University of Bern. Translated from the French by J. SNOWMAN, M.D., M.R.C.P. Royal 8vo. Pp. 247, with 118 illustrations and a Bibliographical Appendix. 1924. London: Bale, Sons & Danielsson, Ltd. 21s. net.

THE title states that this is a contribution to the study of the subject, and the Introduction very clearly sets forth the aims of the book. "It is to describe those few methods which daily experience of the operation has impelled us to adopt, and to emphasize those details which are essential for a beginner to realize. We have no desire to teach surgeons who are satisfied with their own method." It is not the intention of the author to review the whole pathology of the gland, but the importance of realizing the functional value of residual thyroid tissue in different

types of goitre (at operation) is stressed, and, in order to assess this, the necessity for biological study of goitrous tissue.

The contents of the book are excellently balanced. The surgical anatomy of the thyroid is dealt with sufficiently for all practical purposes, especial attention being given to the fascial planes of the neck in relation to the thyroid gland, the vessels, and the parathyroid glands. This is important in what may be called the 'de Quervain' method of approach to the arteries in operations on the thyroid gland.

In the chapter on physiology, current theories are tested in the light of the author's personal investigations, and the reader is left with opinions that are rational, and are as clear as the present condition of the subject permits. One feels the fairness of the author's criticism and the sanity of his judgement. As regards etiology, he realizes that, although much work has been done, the causes of goitre are not yet established.

Probably the most useful chapters in the book are those devoted to pathological anatomy and pathological physiology. After the extensive nomenclature which has grown around the varieties of goitre in the literature, Professor de Quervain's concise description of the types, with the illustrative microphotographs, is extremely clear. In these chapters he is not reviewing literature. It is personal work of the highest order, written by one who already knows all that is available of the work of others. Although this book is intended primarily for surgeons, these chapters particularly have a wider interest.

Under diagnosis much useful information is given, and the value of X-ray examination in intrathoracic extension of goitre is shown. The extent of the tumour and the position and degree of compression of the trachea can be accurately determined by this means, and by this means alone.

The present position of the prophylactic treatment by means of iodine in Switzerland is dealt with. It is shown that if administered in cooking salt the amount of iodine should be infinitesimal—5 mgrm. of iodine to a kilo. of salt. When a decigram per kilo. of salt was used, grievous results followed. The smaller amount is now used, and, as well as this, during school age, 1 to 2 mgrm. of iodine is given in a pastille weekly for a year, and afterwards whenever required. De Quervain rightly states that there is still much to be determined in the matter of prophylaxis, and that this cannot be studied in the laboratories alone. We feel that this is important. The morbidity from goitre in most countries is very high, and if it could be found possible to put aside the ward of an infirmary where clinical investigation could be carried on side by side with facilities for physiological and pathological laboratory work, great good would be achieved.

The chapters dealing with treatment, conservative and operative, will be found most instructive. This part of the subject is treated exhaustively. Indications and contra-indications for various kinds of treatment are given, and one feels all the time that the reasons put forward are backed by large experience, that all methods have been tested, and the best standardized.

As regards operation, surgeons may differ in details—de Quervain is never dogmatic, and explicitly states that he is only describing a safe way; but every surgeon will agree that his method is a very sound one, and no surgeon who follows his directions will go far astray. One point might be mentioned because it gives the key to two different methods of attack on large diffuse goitres. De Quervain ligatures the four main arteries, and then almost bloodlessly removes a wedge from each side and as much of the isthmus as is necessary. This is a clean and efficient operation; but it has always seemed to the reviewer that, as these goitres consist of tissue much below the normal in function, it is wise to conserve to the utmost the blood-supply of the residual gland tissue, and that therefore it is wiser not to ligature the main vessels outside the gland, but to pick them up as the gland is sliced. It makes the operation slightly more bloody, but it leaves the remaining gland tissue much better vascularized. This is a matter of personal opinion.

In the chapter on malignant goitre, it is shown how difficult—and sometimes how impossible—it is to differentiate between the various types of malignancy, either clinically or microscopically, and in the chapter on thyroid deficiency a warning note is sounded as to the success of thyroid grafting.

Exophthalmic goitre is not relatively so prevalent as other types of goitre in Switzerland, but the pages devoted to it are written with the same knowledge and judgement as is the rest of the book. Altogether Professor de Quervain has compressed into 215 pages an astonishing amount of information of the highest order. It bears no evidence of compression. It is lucid. It covers the ground so well that singularly little of importance is omitted. On some matters it is illuminating to a degree, and on all it is most helpful.

A word about the translation. The reviewer has not seen the original, but it seems to have lost nothing in the process. For all one can tell, it might have been written by a master of English, and both Professor de Quervain and Dr. Snowman are to be congratulated.

Manual of Surgery. By ALBERT CARLESS, C.B.E., M.B., M.S. (Lond.), assisted by CECIL P. G. WAKELEY, F.R.C.S. Eleventh edition. Demy 8vo. Pp. 1570 + x, with 664 illustrations, 15 coloured plates, and 76 radiographic plates. 1924. London: Baillière, Tindall & Cox. 30s. net.

This work has become so much regarded as the standard text-book of surgery for students that it would be scarcely necessary to review it in any detail, even if this were possible in the space at our disposal. The war-time surgery has been to a large extent incorporated in the body of the book, but a short terminal chapter dealing with special points in military surgery has been retained at the end.

Mr. Wakeley is largely responsible for bringing the book up to date and for the addition of numerous sections and illustrations describing new procedures. Special attention has been given to the prevention and cure of deformities, the so-called orthopædic surgery.

The book possibly suffers a little from the fact that, whilst a great deal is new and modern, a great many of the old illustrations and descriptions have been retained though often of an obsolete character; as an example, *Fig. 325* shows a pattern of Thomas's walking knee-splint which is never used now. However, the work as a whole represents a positive mine of information, and we know no other which is quite its equal.

Handbook of Operative Surgery. By Sir WILLIAM IRELAND DE C. WHEELER. Demy 8vo. Pp. 441 + xvi, with 298 illustrations. 1925. London: Baillière, Tindall & Cox. 15s. net.

This is the fourth edition of Sir William Wheeler's small handbook of operative surgery, and the fact that it has run through three editions in the course of nineteen years is indicative of its value.

It is a thoroughly sound practical book, in which the most important points of all the ordinary operations are put forward in a clear and concise manner.

Selected Essays on Orthopædic Surgery. By NEWTON MELMAN SCHAFER, M.D., F.A.C.S., Emeritus Professor of Orthopedic Surgery, Cornell University Medical College, etc. Medium 8vo. Pp. 636 + x, illustrated. 1923. New York and London: G. P. Putnam's Sons. \$5.

It is perhaps difficult, particularly in this country, to understand the reason for the publication of this collection of essays. Most of them were first published many years ago, at a time when antiseptic surgery was in its infancy. In some cases the essays involve the recognition of important principles accepted at the present day—for example, that on non-interference in abscess in chronic tuberculous disease of the bones, which happens, however, to be a later essay, and that on fracture of the neck of the femur, in which extension in a position of abduction is advocated. Others favour principles which, although accepted among the older orthopædic surgeons, must be looked upon as definitely out-of-date at the present time. In the essay on derangement of the knee-joint, treatment by a knee cage is advocated, and from a footnote added recently it would appear that the author is still opposed

to operation ; whilst in an essay on knock-knee and bow-leg a rack splint, somewhat similar to that used in this country for a period of perhaps fifty years, is still advised in preference to osteotomy.

It is probably true, as Professor Lovett says in his foreword, that Schaffer persisted in pressing for the conservative mechanical treatment of tuberculous disease at a time when operation was being much advocated ; but he was by no means alone in this attitude, either in America or in this country. A second point with which Schaffer's name is associated is the so-called "non-deforming club-foot". In this he did real service by calling attention to minor disabilities of the foot, which can be readily treated by mechanical means ; but even here his pathological description must be considered to be out-of-date at the present time.

The book can only be recommended as one for a library and as suitable for those who are interested in the historical side of orthopædies.

Rejuvenation: The Work of Steinach, Voronoff, and Others. By NORMAN HAIRE, Ch.M., M.B. Demy 8vo. Pp. 223, illustrated. 1924. London: George Allen & Unwin Ltd. 7s. 6d. net.

IN this book, written for the 'educated layman' as well as for the medical practitioner, Dr. Haire recounts the observations and claims of Steinach, Voronoff, and others, together with accounts of twenty-five cases on which he himself has performed a 'rejuvenating operation'. The first quarter of the book is devoted to the experimental bases on which such operations are founded. To any one who is accustomed to observations upon laboratory animals the effects claimed for transplantations of sexual organs within the same species will not be so convincing as to the uninitiated—as, for example, in the claims for increased longevity, whilst the effects attributed to heterologous transplantation will be met with incredulity. The greater part of the book is given over to the records of cases which have been submitted to vasoligature or testicular transplantation by various foreign surgeons. The general impression gained from a reading of these cases suggests that whatever the method employed, "Conrad in search of his sexual ambitions" meets with his reward of more or less fleeting joys.

However, there would seem sometimes to be a certain amount of general benefit—how much it is impossible to compute—which may be derived from the absorption of testicular 'hormones' from slowly degenerating gland tissue.

Infantile Paralysis in Vermont, 1894 to 1922: A Memorial to CHARLES S. CAVARLEY, M.D. Pp. 375, with numerous charts and drawings. Burlington, Vermont, State Department of Public Health.

THIS book consists of the principal writings of Dr. Cavarley descriptive of the special epidemics of poliomyelitis which took place in Vermont between 1894 and 1917. These papers are preceded by an appreciative biographical note of Dr. Cavarley.

After the description of the epidemics, seven very valuable chapters, chiefly from the pen of Robert W. Lovett, are added, dealing with the treatment of infantile paralysis and the organization of its after-care. Great stress is laid on the early recognition of the disease and its treatment in its early stages by complete rest. It is shown that in the upper limb the most severe paralysis affects the proximal muscles, whilst in the lower limb it is the distal muscles which are most often completely paralysed. The suggestion is made that this distribution is determined not by the original lesions entirely, but in part at any rate by the muscles concerned being those which are subject to the greatest strain. In the arm the weight of the limb affects the proximal muscles, whilst in the leg the weight of the body throws most strain on the distal muscles.

The course of the disease is divided into three stages. The first is that of infection, marked by fever and tenderness, which lasts for about one month ; the second or quiescent stage lasts for about two years, and during the whole of this time recovery of apparently paralysed muscles may be secured wholly or in part

by suitable treatment. This treatment consists in the main of rest obtained by appropriate splinting, together with muscle re-education. The important point is made that, in the early stages of recovery, if the muscle is fatigued it will lose its power permanently. Possibly this is one of the reasons for the common association of the glutei, quadriceps, and calf muscles, as these are the muscle groups associated with the act of standing. If the patients are allowed to stand as soon as they can possibly do so, it is easy to understand why these groups of muscles should become finally paralysed. In the third stage of the disease the amount of paralysis is definite and final, and the treatment consists in the cure of contractures or deformities and the employment of tendon grafting, fixation of joints, and the application of apparatus.

The six concluding chapters of the book are by Drs. Aycock, Amoss, and Taylor, and give an account of the Research Department of the Vermont State Board of Health, dealing with acute poliomyelitis. Certain species of monkeys can be inoculated with the disease, and an examination of the cord from these experiments has yielded interesting results. The disease consists essentially in a patchy myelitis in which the blood-vessels throw out a diffuse round-celled infiltration, which ultimately destroys some of the nerve-cells in the grey matter. This experimental evidence gives a rational basis for the treatment of the disease in its early stages by prolonged rest, because it shows that the destruction of the nerve-cells is not a primary phenomenon, but a secondary result of a diffuse inflammation.

Practical Surgery Illustrated. By VICTOR PAUHEU. Translated by F. R. B. ATKINSON, M.D., C.M. (Edin. Univ.). With an Introduction by Sir CHARLES GORDON-WATSON, C.M.G., F.R.C.S., Surgeon and Joint Lecturer in Surgery, St. Bartholomew's Hospital. In two volumes. Imperial 8vo. Vol. I, pp. 293 + xiii; Vol. II, pp. 252 + ix. 1924. London: Ernest Benn Ltd. 18s. 6d. each.

It is a great task to attempt the compilation of an atlas of surgery where the drawings are made at actual operations. Of necessity it must be spread over a considerable time. There are, of course, drawbacks, for inevitably different aspects of a subject are scattered without any definite arrangement throughout the book. This defect might be remedied at the cost of a certain amount of trouble in subsequent editions. On the other hand, the advantages are manifest. The reader at least knows that he is dealing with real things, and sees the steps of operations which have actually happened. The artist has carried out his work extremely well, though obviously he has resorted to much simplification at times. Always, however, he depicts essentials.

In Part I the first chapter, on surgical organization, cannot be considered very satisfactory. Then follows the consideration of hernia, hydrocele, acute appendicitis, adenoma of the breast, and hemorrhoids. These are very ordinary chapters, yet worth perusal, for, all through the book, the author gives practical hints from his own experience, some of which are valuable, some not. Nevertheless they reflect the opinions of a skilled operator with a large experience. We do not, for instance, agree with him that it is advisable to use buried silkworm-gut sutures in the treatment of hernia; but his advice to make the smallest possible incision and do nothing but drain when there is a circumscribed appendix abscess is good.

A number of other routine operations are described, including an attractive method of curing a vesicovaginal fistula, after which the author treats of carcinoma of the rectum. Abdominoperineal excision is regarded as the operation of choice when it is possible. Pauhet says that of four patients who consulted the surgeon with carcinoma recti, in one the disease was inoperable by operation, two were operable from the perineum in two stages, and one in one stage by the abdominoperineal method. These proportions are almost the reverse of the general experience in this country, where about 70 per cent of patients are inoperable when first seen. The section on gastrojejunal ulceration should be read, but that dealing with chronic intestinal stasis is not convincing. We note that the author still uses the Murphy button on occasion.

In Part II Thiery de Martel gives an excellent description of cerebellar operations, whilst J. L. Faure and H. Rubens-Duval write on the operative and other methods of treating carcinoma of the uterus. The rest of the book is by Pauchet. On the whole, this volume is better than the first. He shows the removal of a very large renal tumour through a transverse abdominal incision. There is a chapter on prostatectomy. To gauge the suitability for operation as far as the risk from uræmia goes, the determination of Ambard's constant is recommended, as well as the value of the urea in the blood. The figure for the latter must be about 0.35 to 0.45 to allow of prostatectomy. This errs on the side of caution. Often the operation can be brought to a successful issue when the blood-urea is greater than this. The two-stage method is employed in 40 per cent of cases. The mean mortality from suprapubic prostatectomy has been double that of the perineal operation, which is the one selected for illustration in this volume.

Complete gastrectomy has been performed by this author no fewer than five times. Three of these patients survived. The author shows how the œsophagus is sutured to a loop of jejunum brought up through the mesocolon, the limbs of the loop being anastomosed together below that structure. The Y-gastro-enterostomy is still performed under certain circumstances. Cæcoplication is illustrated and described, though it is difficult to see any rational basis for this operation. The volume ends with another chapter on cancer of the rectum, where a very clear description of the abdominoperineal operation is given.

These books are marred by faulty translation and inefficient proof-reading. It is surely the aim of the translator of a foreign author to convey his meaning as exactly as possible, but we find here a slavishly obstinate adherence to the French method of expression and construction which is very irksome to the reader and frequently leads to obscurity.

Die Ueberpflanzung der männlichen Keimdrüse. By Dr. ROBERT LICHTENSTERN. Pp. 113, with 16 illustrations. 1924. Vienna: Julius Springer. Kronen 75,000; dollars 1.05; gold marks 4.40.

THIS monograph on transplantation of the testicle gives much useful and interesting information on the subject. The author begins with a chapter on the influence of the testicle on secondary sexual characters; he then describes the nature and functions of testicular cells and the effects of X rays upon them, and gives a good summary of much experimental work that has been done upon the lower animals by various observers.

Transplantation in man is discussed, and a full description is given of the operation recommended. Full clinical details are supplied of a series of cases in which both testicles had been lost as the result of injury or disease. Transplantation of a human testicle taken either from other patients operated upon for hernia, or from generous relations, was performed in each case. The conditions of eunuchoidism and homosexuality are then described at considerable length. The results of transplantation operations for both these conditions are fully described. A short critical summary of the results of the twenty-two transplantation operations upon which the monograph is based completes the work, which is worthy of careful study by those who are interested in this branch of surgery.

The illustrations are mostly photographs of patients after operation. There is a good bibliography of four pages.

Le Pancreatiti. By Dott. DOMENICO CALZAVARA. Imperial 8vo. Pp. 392, illustrated in black and white and in colours. 1924. Bologna: Licinio Cappelli. Lire 30.

THIS monograph, which issues from the University of Padua, covers existing knowledge of the conditions, with the curious exception of a very meagre reference to Banting's work. It suffers, but not so severely as some similar Italian works, from a disinclination to appraise the multitudinous opinions and descriptions quoted with so much industry and care. Here, however, the author is perhaps absolved,

for he includes a considerable section of reports of his own experimental work and illustrates it by excellent photomicrographs.

The scheme of the book embraces three parts. The first, general, covers the anatomy, physiology, etiology, pathogeny, morbid anatomy, and symptomatology of pancreatitis generally. The second part deals with the forms of acute pancreatitis, suppurative and non-suppurative, and acute necrosis; and with the chronic forms, including syphilitic, tuberculous, and lithiatic. The third part details experiments on the production of acute necrosis by obstruction of the intestine, and on the effect of introducing bile into the ducts during activity of the gland, and in the resting state.

Probably the monograph gives an accurate reflection of the present state of knowledge of the disorders. It leaves the impression, doubtless correct, that bedside diagnosis is still very uncertain: it turns, in the spirit of the times, to elaborate biochemical tests to supplement the failure of clinical acumen; but whilst on the one hand it discloses the complete unreliability of such a test as Cammidge's, it offers the discovery of 'hyperglycemia without glycosuria' as a critical test for the diagnosis of a condition so blastically desperate that its author adopts the phrase of Giordano—'dramma pancreatico'—for its description.

The book is well written, supplies ample bibliographies, and deserves to be read.

Urologisches Praktikum. By Professor Dr. I. CONN, Berlin. Second edition. Crown 8vo. Pp. 399, with 91 illustrations and 3 coloured plates. 1924. Berlin and Vienna: Urban & Schwarzenberg. Schw. fr. 11.25.

This is a real 'handbook', and is an attempt to cover a great deal of ground in a small space; it is well printed, and clearly but very concisely written. The illustrations are mostly of various instruments, and there are three coloured plates, one of urethroscopic pictures and two of cystoscopic appearances.

In the introduction to the first edition the author mentions that the book was written rather for students and those in general practice than for the urological specialist; he therefore confines himself to the description of the indications for operation, and does not discuss the details of operative technique: in the enumeration of the various therapeutic measures he tries to accentuate those that are within the reach of the general practitioner. The second edition has been added to, and contains the details of X-ray examinations, including pyelography, and a discussion on the importance of the different methods of estimating kidney function.

The book is divided into three sections, the first of which is devoted to methods of examination; the second to an analysis of the various symptoms that may arise in diseases of the urinary organs; and the third to a short description of the diseases appertaining thereto.

On the whole, this book gives a fair précis of modern urological practice, but there are some omissions which must strike the English-speaking urologist as astonishing. To name just a few examples: Under the heading of the estimation of kidney function, the injection of indigo-carmin is given rather a prominent place, but the author recommends its injection into the muscles of the buttock. In our experience, this procedure is apt to leave a hard and painful nodule which may take a very long time to disappear, and the appearance of the dye in the urine is sometimes delayed for half an hour or more: this is very trying both to the patient and the surgeon; injection of the dye into a vein is much less painful and can be relied on to act much more expeditiously; the author does not even mention this method.

In discussing the indications for prostatectomy, we cannot find any allusion to the estimation of the blood-urea; yet most English surgeons would attach more importance to this particular examination than to any other single factor. Again, there is a long discussion on the non-operative treatment of *Bacillus coli* pyelitis, but amongst the numerous remedies recommended one looks in vain for any reference to the use of alkalis.

We are surprised to find that Professor Dr. Cohn prefers nephro- to pyelolithotomy; the reason he gives is that stones in the cortex may be missed by the latter incision; this has not been the experience of most surgeons, and the risk of incising the kidney is very much greater than that of making an opening into the pelvis; hæmorrhage never follows the latter, and many kidneys have had to be removed for secondary bleeding after nephrolithotomy.

For hæmaturia from stone in the kidney, the author advises rest in bed, the administration of various styptic drugs, and, if necessary, the injection of gelatin; we suggest that a simpler way to combat the bleeding, which is seldom severe, would be to remove the stones from the kidney, or, if that were not feasible, to take away the kidney.

Lastly, we totally disagree with the following teaching on the subject of hæmaturia. After giving an excellent account of the causes of this symptom and stating that it is only a symptom, "*Die Hämaturie . . ist nur ein Symptom*", he goes on to say, "Nevertheless it will be the first duty of the doctor to bring the bleeding to a standstill". In our opinion, this is frank urological heresy; the first duty of the doctor is to send the patient to a hospital or nursing home where cystoscopy can be carried out and the cause of the hæmaturia investigated; only if this is taught will the unfortunate sufferer from an early tumour of the kidney ever have a chance of a permanent cure.

Allgemeine und spezielle chirurgische Diagnostik: ein Lehrbuch für Studierende und Ärzte. By Professor Dr. MAX KAPPIS. 4to. Pp. 652 + xxiii. Illustrated. 1924. Berlin: Urban and Schwarzenberg. Paper cover, 15 gold marks; Bound, 18 gold marks.

THIS is a type of book of which there are few examples in the English language. The diagnosis of surgical affections is treated exhaustively as far as this can be done without the demonstration of actual clinical cases. Professor Kappis is of the opinion that the tendency to relegate diagnosis to the physician, and technical procedures only to the surgeon, who shall perform them at the behest of his medical colleague, is essentially wrong. Nobody can weigh the gravity and consequences of operating, or refraining from intervention, with the accuracy of the surgeon of experience. It would, therefore, be a catastrophe were the art of surgical diagnosis neglected by oncoming generations of surgeons. These were the grounds prompting him to write this book.

In the first part of the treatise the general condition of the patient is considered, such as the efficiency with which the vital functions are carried on, the state of the blood, the skin, and such matters as the influence of constitution as far as can be gathered from body weight, development, investigations of the vegetative nervous system, and so on. Part II deals with the general surgical diseases, such as syphilis, actinomycesis, and affections of tissues, skin, bone, nerve, blood-vessels, and joints. In Part III surgical diseases are treated according to the part of the body affected.

All through the book the principles of diagnosis are clearly and fully laid down, and appear to be thoroughly up-to-date. There is a splendid series of illustrations, which number more than 600, with a few coloured plates. The arrangement of the book leads to a certain amount of overlapping and the necessity for cross-reference, but this can scarcely be considered as a blemish. Taken as a whole, it is a very satisfactory treatise.

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with flatus had also passed by the anus. The lower abdomen, though still tender, had lost its tension, and the rigidity was less marked. Three days after the operation a tender swelling developed in the right iliac region. There was also some suppuration of the incision of the second operation. The right iliac swelling was opened two days later, and proved to be an abscess in the abdominal parietes, probably due to extension of infection from the region of the second operation. No leakage took place at the lateral anastomosis. When the Paul's tube came out, there was a considerable escape of semi-fluid intestinal contents from the cæcostomy, and the bowels also continued to act per anum. The patient's temperature fell, the wound assumed a healthy aspect, and her appetite returned. For some time after the operation a fluid action of the colotomy wound followed each meal. Nutrition rapidly improved and strength returned. The cæcostomy wound contracted and closed.

The anæsthetics were given by Mr. Herbert Charles. I am indebted to Drs. A. J. Hogg and W. B. Stanford for their unremitting care in the after-treatment, which alone rendered recovery possible.

The patient remained well for years afterwards, but was reported in 1924 to present signs of pernicious anæmia.

Case 2.—Mr. B. B., an actor, age 24, had been ill for a fortnight in 1917 with symptoms at first thought to point to appendicitis, but later considered to be due to pneumonia on account of signs at the right base. On the tenth day of his illness he was moved from Southend and placed under the care of the late Dr. Wright, of Warwick Crescent. On the following day his temperature descended by crisis, but on the thirteenth day he complained of pain in the right iliac fossa and Dr. Wright noticed a lump there. The next day he was worse, and I was asked to see him. He was in good general condition with a pulse of 84 and a temperature of about 100°. The abdomen was soft and moved on respiration, but in the right iliac fossa there was a large definite lump extending upwards and backwards into the right lumbar region. Dr. Wright and I agreed that an appendix abscess was present, and the patient was operated upon the same evening. A large quantity of fetid pus was evacuated through an incision in the right iliac region. The abscess cavity was sloughy and extended upwards in the right loin as far as the liver. A counter opening was therefore made in the right loin. The appendix could not be found and had apparently sloughed away. A prolonged search for it was not considered advisable. The cavity was washed with normal saline and with flavine, 1-1000. The following morning at 6 a.m. he had passed urine and had not vomited, but flatus had not passed. He was perspiring freely. At 6.30 p.m. the day after operation, he vomited for the first time, and this was repeated frequently during the succeeding night. On Oct. 1, a turpentine enema and injections of eserine and pituitary were unsuccessful in causing the passage of flatus except in the smallest quantities, and although his temperature had fallen practically to normal, intestinal obstruction was evidently present. On Oct. 2, the abdomen below the umbilicus showed rigidity and a football-like distention, while above the umbilicus it was somewhat distended but not rigid. It was obvious that the patient would die of obstruction unless relieved, and at 2 p.m. on the same day I again operated through a median hypogastric incision. On passing the hand into the pelvis some turbid fluid escaped, and near the bottom of the pouch of Douglas several loculated abscesses containing thick pus were evacuated. Two large drainage tubes were inserted into the pelvis. The condition of the intestines was now investigated. The cæcum was found to be collapsed and almost normal in appearance, but the small intestines below a horizontal line drawn two inches beneath the umbilicus were congested, inflamed, and distended, and sharply kinked in many places by sticky lymph. It was evident that there was a diffuse paralytic obstruction up to the lower part of the small intestine. The incision was prolonged upwards as far as the transverse colon, which was found normal and collapsed. The small intestine in this neighbourhood though distended was not inflamed or oedematous. It was, however, so much distended that immediate relief appeared imperative, and through two small punctures made with a knife and subsequently closed with two purse-string sutures a considerable length of the

jejunum was partially emptied. A coil of distended jejunum was selected above the inflammatory area, brought through a hole made in the great omentum just beneath the transverse colon, and anastomosed rapidly to the transverse colon. Since the pelvic colon was presumably inflamed and obstructed, it was now necessary to provide drainage for the large intestine. The incision made at the first operation was opened up and a large catheter was tied into the cæcum. An evil-smelling, brownish fluid flowing almost at once from the catheter indicated that the small intestine was relieving itself into the transverse colon and thence into the cæcum.

The following day there was a most remarkable improvement in the patient's condition. Instead of presenting the distressed aspect of a dying man, he was comfortable and had lost the expression of anxiety so noticeable the day before. His pulse had fallen in rate, and, instead of being distended, the abdomen was quite flaccid, though still rather convex. Vomiting had ceased and did not again recur. The temperature, however, remained high, and on Dr. Wright's suggestion, anti-streptococcus serum was administered with apparently excellent results. The catheter came out of the cæcum on the fifth day, but even before this time the bowels had acted normally. About three weeks after the operation a recurrence of pyrexia with rapid pulse and cardiac distress was apparently caused by a residual abscess at the bottom of the pelvis. This was treated by hot rectal injections of water and ruptured into the rectum.

At the present time (1924) the patient is, I believe, quite well.

Case 3.—On the night of March 13, 1918, Mrs. J., age about 30, was seized while in bed with a sudden acute abdominal pain. Dr. J. J. Edwards was called in and found some rigidity of the right rectus muscle. The temperature was normal and the pulse not much raised. He diagnosed appendicitis. The following morning he asked me to see her. I found the abdomen slightly and uniformly distended. There was marked tenderness of the right iliac fossa and here a definite resistance could be felt. The lower part of the right rectus muscle was distinctly rigid. Immediate operation was advised, and was carried out as soon as the patient could be removed to a nursing home. An incision in the right iliac fossa showed free pus surrounding the cæcum. The rest of the abdomen appeared to be free of infection, but there were no barriers of any sort to impede the pus. The appendix was rather swollen and rigid, but was not distended or strictured. The cæcum was greatly distended by flatus, and much congested. I was in doubt whether the case was appendicitis or typhlitis. Either diagnosis seemed possible, but in any case the bacterial invasion of the abdomen had not occurred through a gross perforation. As infection of the pelvis seemed to be a certainty, a small opening was made above the pubes and a drainage tube introduced into Douglas' pouch. The Fallopian tubes were congested, but otherwise normal, and there seemed no evidence of ascending genital infection. The following day the bowels had acted and flatus had been passed as the result of turpentine enemas, but below the umbilicus the abdomen was distinctly swollen and the lower halves of both recti were rather rigid. Injections of eserine and pituitary extract were ordered. No vomiting had occurred, but the pulse was more rapid than on the previous day. An injection of antistreptococcus serum was given. The day following the patient seemed more toxic; she was rather drowsy and apathetic, and a large dose of serum was administered, apparently with great benefit. A cultivation of the pus had shown the presence of the streptococcus. The distention below the umbilicus was more marked, but vomiting still remained absent. A day later the sub-umbilical distention had increased still further, and now conveyed the impression of a half-inflated football in the lower part of the abdomen. The epigastric region was convex but soft. The patient vomited several times. It was evident that almost complete paralytic obstruction was present. The pulse had increased to 120. She was seen with me by Dr. Campbell Thomson, who agreed that her condition was hopeless unless something further was done. The abdomen was re-opened on March 19, and almost the whole of the small intestine was found greatly distended, pressing the transverse colon upwards and forwards so that it could not be reached. The ascending colon was drawn out from the wound, and a distended

coil of jejunum was anastomosed to it. A small Paul's tube was now tied into the cæcum.

At the end of the operation the patient's condition was very grave and her pulse 140. The anaesthetist, when he saw me the following day, refrained from asking about the patient because he felt sure she could not survive the night. However, the following morning—March 20—her condition was rather better. During the thirty-six hours following the operation, 36 oz. of fluid were passed by the cæcal tube. On March 21, the improvement was great; the abdomen was quite soft though still distended below the umbilicus; above the umbilicus it was flat. The pulse, though rapid (140), was full instead of being small and feeble as on the previous day. On this day for the first time she began to take food in quantity; $4\frac{1}{2}$ pints of fluid nourishment were administered by the mouth during the day. At night she was a little toxic and drowsy. About 20 oz. of urine were passed in the twenty-four hours following operation. The temperature was normal. On March 22, she was much troubled by hiccups; the abdomen was soft and wrinkled. Her morale, which had been extraordinarily good, went to pieces about this time; she was tired and was inclined to give up the struggle. She only recognized friends slowly and with difficulty, and asked for morphia although she was not in pain. During this day she passed about 44 oz. of urine. The force of the poison on the viscera appeared to be exhausted, but it was now playing havoc with her nervous system, upon which in the early days it had seemed to act as a stimulant. The temperature was steady on the normal line and she took food well, but the pulse remained between 130 and 140. Its rapidity in proportion to the temperature was a characteristic feature of the case all through. On March 23 there was incontinence of urine and faeces. The patient was drowsy and did not recognize visitors, lying with eyes half open in a state of semi-coma. The tube continued to act well and the abdomen was now perfectly flaccid though still convex; it moved freely on respiration. Œdema of the vulva had appeared, probably due to intense pelvic peritonitis and consequent œdema of the pelvic cellular tissues. Three pints of fluid were passed by the cæcal opening and $3\frac{1}{2}$ pints of fluid were taken. On the evening of the same day, the patient was quite clear in her mind, with a strong voice and a better pulse (128). The anus had this day acted more than the tube, and had passed partly-formed motions. The abdomen, everywhere flaccid, was slightly concave above the umbilicus and slightly convex below it. The abdominal stitches were irritating and cutting through. The vulva œdema had nearly gone. No incontinence of urine; tongue moister. There was marked painful swelling of the right parotid gland. On the 24th the improvement was maintained. Four loose motions were passed per anum and very little fluid was drained away from the cæcum. A right parotid abscess was opened and washed out with flavine. On the 26th the Paul's tube was removed and the fistula plugged with gauze. The patient was comfortable, and was taking food well. Temperature normal, pulse 128. The same day there was some secondary hæmorrhage from the abdominal wound which weakened her considerably. On the 27th, under an anaesthetic, the cæcal opening was closed and the abdominal wound re-sutured. Owing to intense local infection, all the old stitches had cut through and the wound was gaping widely. After the operation she was much collapsed, and for several days her condition was very critical, but she again rallied. On the 28th the lower part of the abdomen was found to be distended. Owing to a misunderstanding, the flatus tube had not been regularly used subsequent to the closing of the cæcal fistula. On April 1, she had rallied enough to enjoy solid food such as chicken, and she smoked a cigarette although still in an exhausted condition. Later in the day a profuse fecal discharge took place from the abdominal wound, owing to the breaking down of the cæcal opening. This was a very unfortunate event, and gave rise from this time onwards to great trouble. On April 2 she complained of pain in the right elbow. On the 3rd some hæmorrhage took place from the bowels: this was repeated on the 4th. On the 5th the abdominal wound was looking cleaner and granulations were forming on its edges. The stitches were again cutting through. The wound was strapped across to hold it together. On about April 5, she developed a cough with some purulent expectoration, but no signs of empyema could be detected. She continued to take food well. On the 7th she

was still taking solid food and again enjoyed a cigarette: pulse 128. On the 8th it was noted that the abdomen was perfectly flat and soft—if anything retracted, and the wounds were beginning to granulate. A swelling was noted on the right shoulder and was incised. It contained pus but did not communicate with the shoulder-joint. The nurse notes that she had taken food well and seemed very bright in the evening. She had a good night and slept well. On the following morning (the 9th) she felt tired out and seemed very weak, although she continued to take food well. From this time she began to go downhill rapidly from wasting and exhaustion. On the 14th a fluctuating swelling was detected to the left of the 4th dorsal vertebra: at this point the spine showed an angular change of direction due either to a pyæmic abscess in the vertebra or to the lighting up of an old spinal caries. A fluid swelling appeared in the sacral region, evidently another abscess, her lips were blue, and there was much bronchial secretion which she could not get up without painful effort. She sank into a state of semi-consciousness and died on April 15.

Case 4.—Mr. M., age 24, on May 8, 1923, felt discomfort and nausea during the day, and vomited four or five times during the night, but on the next morning two pills he had taken acted well, and he ate scrambled eggs for breakfast. Dr. W. A. Rudd saw him at 11 a.m., and suspected appendicitis. An hour or two later terrible right iliac pain suddenly came on and got rapidly worse. When I first saw him, about 2 p.m. on the same day, there was acute deep tenderness in the appendix region, a raised temperature, a pulse of over 100, and abdominal rigidity in the right iliac and lumbar region. Retrocæcal appendicitis was diagnosed, and at 4 p.m. the abdomen was opened by a small median hypogastric incision. The pelvis was found to be full of pus, and a large drainage tube was introduced into the rectovesical pouch. The appendix was then removed through a right iliac incision. It was swollen and intensely inflamed, and presented a patch of gangrene. The pelvic intestines, though inflamed, presented no evidence of paralysis. Nevertheless, the onset of paralytic obstruction was feared, on account of the repeated vomiting. Continuous saline was given per rectum. Pituirin, 1 c.c., was given every four hours, and also several turpentine enemata. Flatus passed only in very small quantities until the 11th, when a turpentine enema produced a good result and gave much relief. At this time the temperature was 99.2° and the pulse 78. On the 12th calomel was given hourly in $\frac{1}{16}$ -gr. doses for twelve hours. Flatulence was troublesome, and he vomited for the first time since the operation. During the early morning of the 13th he vomited copiously a brownish fluid, and a turpentine enema evacuated only a very small amount of flatus. Hiccup came on occasionally and became continuous. Distention increased and vomiting returned and became bilious. He was restless and uncomfortable. The pulse rose to over 100, and the temperature was slightly subnormal. Late on the evening of the 13th, when I saw him again, he presented a typical picture of hypogastric peritonitis. The abdomen was rigid up to the umbilicus; above this, though the muscles were stretched from distention, there was no rigidity. On deep palpation a firm but elastic football-like mass seemed to occupy the central hypogastric region, while above this level the intestines were distended. The pelvic tube was draining freely and the bladder was empty. It was evident that his condition was desperate. Two pints of offensive brownish fluid had been vomited during the evening. At 2 a.m., under light anesthesia, the abdomen was re-opened just to the left of the umbilicus, and search was made amid distended but uninflamed coils of jejunum for the transverse colon. It appeared to be fixed high up in the abdomen and could not be reached. The right iliac incision was therefore re-opened, and an uninflamed coil of jejunum was brought down and anastomosed with the cæcum, into which a Paul's tube was subsequently tied. The operation caused serious shock, but at 6.30 a.m. the temperature was 98.8° and the pulse 102. The distention of the abdomen was relieved within twelve hours of the operation, but for two days the patient's general condition gave rise to great anxiety. The tube in the cæcum was repeatedly blocked, and was kept clear by injections of saline, sometimes combined with Epsom salts. He vomited a brownish fluid twice on the 14th. Temperature 99.8°, pulse 132, colour bad, some delirium. During the night of the 14th the bowels acted, the stool was liquid and